



SCHOOL OF GRADUATE STUDIES

**AN ASSESSMENT OF CONSTRUCTION EQUIPMENT
MANAGEMENT PRACTICE AT DEFENSE
CONSTRUCTION ENTERPRISE**

BY

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ABBREVIATION

MOND	Ministry of National Defense
DCE	Defense Construction Enterprise
CEM	Construction Equipment Management
MN	Mean
SD	Standard Deviation
SPSS	Statistical Package for Social Science
PPM	Planned Preventive Maintenance
PCM	Planned Corrective Maintenance
CE	Construction Equipment

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ABSTRACT

Construction equipment is one of the major resources in the construction process for construction companies. This study aims to examine the practice of construction equipment management in Defense Construction Enterprise. The study focuses on examining the practice and challenges like lack of clear policy and guidelines, availability of the spare part, lack of training and development, lack of skilled manpower and other factors that could influence construction equipment management practice in DCE. To answer research questions the study adopted the mixed research approach. The study employed descriptive research approach and used secondary data and also primary sources like structured questionnaire and interview were carried out with enterprise management numbers, project managers, case team leaders and senior technicians. The survey and interview was conducted through purposive sampling technique. For the sake of achieving the objectives of this study, questionnaires were analyzed in descriptive form and findings were displayed in a table with assistance of a statistical package for the social science (spss) program and data from interview and document reviews were interpreted qualitatively. The results show that construction equipment management practice from various perspectives of equipment management aspects in defense construction is assumed to be poor. Based on findings, recommendations like creating awareness to all employee, implement clear CEM policy and procedures to enterprise management bodies, to project managers of enterprise and suggestions for other researchers are forwarded. The challenge encountered in this research was lack of important data materials. The completion of the study assisted the construction equipment administration and maintenance support process and other process owners of the enterprise to determine its performance status and pin-point areas where there are shortcomings in the enterprise construction equipment management efficiency.

Key words: equipment, equipment management, construction and management

CHAPTER 1

Introduction

1.1. Background of Study

Construction industry is one of the most important service industries which touch the lives of millions of people in Ethiopia. As a result, it is firmly believed that construction industries need effective resource management practice to retain their profitability and continue their contribution for the growth of the country. Construction is a business sector that relies primarily on high utilization of construction equipment. Equipment is thus one of the key factors for improving contractor's capability in performing their work more effectively and efficiently (Day and Benjamin, 1991). By enhancing the effectiveness of utilizing equipment extensive volume of work can be completed within a shorter period of time and, more importantly, within the project schedule. They also suggested that one of the main reasons for project delays on construction projects in Thailand were equipment management problems, deficiencies in organization, shortages of construction materials, and inefficiencies in site workers (Hinze, 1995).

According to Sharma (2002, p.65) the cost of equipment in a project varies from 10 to 30% of the total cost of the project, depending upon the extent of mechanization. In modern fully mechanized projects the cost of equipment goes up to 30%. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for the successful completion of the project. With the growing use of machinery it has become necessary for construction engineers to be thoroughly familiar with the construction application and upkeep of the wide range of the modern equipment.

According to Tatari and Skibniewski (2006) construction equipment is one of the most important physical assets in a construction firm. It plays an important role in construction operations and constitutes a major portion of construction projects.

Hence, proper management of equipment is crucial for the firm success, especially for the construction industry where profit margin is very low. It is important to note that effective management of equipment would engender large savings for construction firms. According (Sahrma, 1999) equipment manager's main task is to reduce downtime, achieve optimum equipment utilization and increase production at minimum cost. The cost analysis and the will of adopting proper techniques suited to the situation are the basic factors for the success and therefore, there is a need for a rational planning, proper selection, and judicious deployment of equipment in relation to the conditions so as to achieve optimum utilization. Equipment engineer should coordinate with various wings of the organization in discharging thier job of equipment planning, balancing, selection of equipment and its utilization, personnel selection and training, financial planning, preventive maintenance and general supervision. Thus equipment management integrates and continuously interacts with human, technical, financial and production system in order to achieve top efficiency and cost effectiveness.

Effective equipment management practice of construction equipment is crucial for the success of construction projects. Inadequate management practices of construction equipment and the subjective decisions on equipment leads to a major loss in the construction industry. On the contrary, effective construction equipment management can make the difference for construction companies. This is true because most of these companies are always looking forward, by the end of the day, to increase profits, reduce maintenance and operating expenses, and optimize utilization and minimize down time (journal of civil engineering and management, 2009). This can be achieved by placing better equipment management practice, proper equipment management system that provides information to make decisions on planning, procuring, and replacing the equipment. Therefore, the primary goal of construction equipment management is to enhance competitive performance and decrease different costs associated with equipment by closely integrating the internal operation within enterprise policy.

However, in managing construction equipment, construction companies are invariably plagued with several difficulties such as huge capital investment in the acquisition phase, which usually constitutes a major financial burden. Procurement of major construction equipment not only take significant percentage of the total construction project cost but also causes daily time uncertainty, which may disrupt the construction schedule (Wireman T.,2006). In the maintenance phase, proper maintenance management of construction equipment is never over-emphasized since the cost and time that exceed the designated budget or schedule on projects are often resulted from poor machine maintenance practices. In the disposal phase, determining equipment economic life and timing for replacement is often problematic because such decision is influenced by various factors such as machine obsolescence and efficiency.

It is incumbent to ensure the construction equipment needed by projects to deliver agreed levels of equipment is available as and when required. This includes managing its finances to meet the cost of maintaining and replacing equipment, and that this equipment is used as efficiently and effectively as possible.

Construction companies, therefore, need:

- > Mechanisms to ensure that construction equipment is acquired on the basis of assessed and prioritized need; and
- > Decisions on construction equipment planning, acquisition, maintenance, use, operation replacement and disposal to be made on the basis of complete and reliable information recorded in asset register.

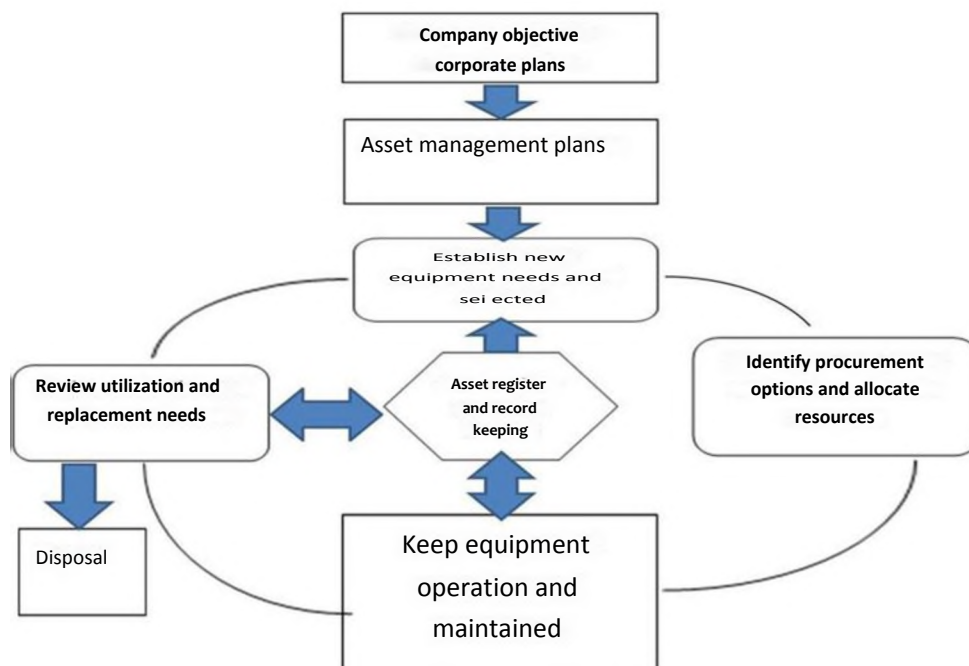
Effective equipment management practices not only increase production time and equipment availability, but also maximize the company profit by reducing several costs such as those from costly downtime. However, researches in the field of equipment management practice, particularly in the construction context, have been rare (Sharma, 1999).

Despite the fact that the Ministry of national Defense, the focus of this research, is currently playing a significant role in the economic development of the country, this role is hampered significantly by mismanagement of construction equipment. This problem is

significantly visible in the enterprise erected under the jurisdiction of the ministry that focuses on providing services to the ministry itself and the nation at large. Nationally, the Defense Construction Enterprise is currently undertaking national construction projects in areas where it is difficult, for security or any other reasons, for the private sector or other governmental institutions to handle. One such example could be the mega construction sites that are located in different Region.

The construction equipment used in an enterprise has a life cycle. It starts with the recognition of an opportunity, then progresses to feasibility and approval. If the idea is found worthwhile a full selection, equipment are purchased, installed and put into operation. The vast majority of the life cycle is its operation and this continues until the plant and equipment are eventually decommissioned and disposed (T.R banga and s.c.Sharma, 2012). Source, audit report of Indian construction equipment life cycle, 1997

FIGURE I:Construction Equipment Management Cycle



1.2. Statement of the Problems

As has been mentioned in the above, the concept of construction equipment management is a crucial component of construction management practices. As crucial as it is, however, this sector of management has been paid less attention. Not only in the areas of construction companies resource management, but also in other specific components of construction equipment aspects ,such as, planning, selecting, procuring, operating, maintain, replacement and disposal etc... practioniers have been observed being ignorant of the significance of adequate level of Construction Equipment Management.

In the countries scenario, construction is taking the largest portion of the country economy. With this same orientation minister of national defense has erected an enterprise that handles construction related activities of the ministry itself and thereby, serve the nation by providing quality and standard services. Like all other construction companies, the enterprise has been adversely affected by construction equipment management practice. This problem requires immediate attention.

Despite the fact that Ethiopia is currently involved in wider construction activity, the concept of construction equipment management, in most cases, has been left of the minds of contractors in their project designing. This significantly affected the effectiveness of the construction equipment companies and the problem appeared to persistently contaminate the whole process of construction. This is difficult to waiting the scarce resources of the nation for mismanagement of available construction equipment would definitely affect values of time, quality, safety and efficiency of construction companies.

Not only the practicing engineers, researchers in the field seen to have forgotten the areas of construction equipment management. Researches out come with this specific area of are either unavailable or not adequately nourished with the information.

In DCE from the current observation, exhibited reports and consultation of some concerned bodies, there are problems related with planning, acquisition, proper utilization, effective maintenance activities, equipment replacement and disposal system, standardization, and recording and inventory systems.

The main cause for inadequate effective equipment management system seems to be the absence understanding about construction equipment management system between all the concerned body such as, management members, construction equipment support process members, and procurement and project management teams. In construction, equipment contribute a great deal towards time, quality, safety and efficiency of a project; in that case the enterprise must manage properly the construction equipment in order to achieve top efficiency and cost effectiveness, otherwise the company's profitability may come down.

Considering the ultimate disastrous outcomes of these problems, the paper attempted to address the problems by assessing the current practices and challenges and then by identifying the gaps between the globally accepted conventional practices and the practices of professionals in the area.

Construction equipment management is being as high as discussed so far, the researcher wanted to explore how effective defense construction is in managing its construction assets. There is no previous work done at defense construction to evaluate its equipment management effectiveness. Neither there is any similar study made in the country on other organization.

Hence, the effort of this research endeavor is to fill this knowledge gap and identify areas of management intervention to improve performance. In addition, the study attempted to identify the problems, challenges and practices of managing construction equipment at defense construction enterprise in order to get wider pictures through the rigorous investigation of the enterprise construction equipment management activities.

However, as is true for all other construction companies, Defense Construction Enterprise has also been a victim of construction equipment malpractices. Therefore, this research will be conducted in order to investigate current practices and problems on equipment management as well as to identify practices that are capable of mitigating equipment management problems from that of DCE perspective. It is believed that a study on construction equipment management practices would contribute great benefits for

construction companies by helping them to enhance their effectiveness in managing construction equipment. Particularly, this study would assess all the above facts regarding construction equipment management practices and it indicate the overall situation of construction equipment at Defense Construction Enterprise.

1.3. Basic Research Questions

This study is, in general, aimed at answering what the equipment management practices in defense construction enterprise are and, more specifically, to find answers to the following basic research questions.

- > Does DCE have strategy, policy and procedures in managing construction equipment?
- > How effective is construction equipment management practices at DCE?
- > What are the challenges of effective CEM practices at DCE ?
- > What could be recommended to improve construction equipment management practice at DCE?

1.4. Objective of the study

1.4.1. General objective

The general objective of this thesis is to identify and assess the various construction equipment management practices that are currently being followed by the Defence Construction Enterprise.

1.4.2. The specific objective

The study aims at addressing the following are specific objectives:

- S* To assess the main equipment management practice at DCE & handling experience within the target enterprise in the construction sector;
- S* To identify the major problems of managing construction equipment;
- S* To assess the effectiveness and efficiency of the DCE with regard to equipment management;
- S* To evaluate the success rate of the recent construction equipment management practice of the enterprise understudy and to identify the weakness; and

S To provide possible suggestion and recommendations to challenges in equipment management practice;

1.5. Definition key Terms

- > Asset Management: - the systematic planning and control of a physical resource throughout its life. This may include the specification, design, and construction of the asset, its operation, maintenance and modification while in use, and its disposal when no longer required (Banga and Sharma, 1998).
- > Equipment:-may be defined as a physical entity which is used to carry out a general or specific activity in the organization, and it also defined as fixed or movable tangible assets to be used for operations example of equipment includes machines, tools, vehicles (Sharma ,2010).
- > Maintenance: - any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions, or to repair the equipment (Wireman T., 2001).
- > construction industry:-Sector of national economy engaged in preparation of land and construction, alteration, and repair of buildings, structures, and other real property(Tatari and Skibniewski,2006).

1.7. Scope of the Study

The general aim of the study is to assess the practice of construction equipment management in defense construction enterprise limiting its scope only in this public construction enterprise. Owing to the broad and the complex nature of construction equipment management practice aspects, this study focused on the different construction equipment management aspect practiced by defense construction enterprise, factors that affects the practice of construction equipment management practice and the challenges that affects it as well.

1.8. Limitation of the Study

The following are the major limitation of the research to be noted possibly having considerable amount of impact on the outcome of the paper. The first of these is

availability of adequate data on the output. Secondly, not being able to see similar works in the country that would enrich this paper. Last but not least, because all the enterprise project sites are at different regional levels are not incorporated in the study and because this exclusion main force the researches to live out potential respondents' in the uncovered projects.

1.9. Significances of the study

The study would have many advantages for all practitioners and academicians by providing useful information about construction equipment management and issues related to its practice. It would also be useful for defense construction enterprise by providing information about the theoretical and challenges of practicing construction equipment management. The study could also be used as an initiation for those who are interested to conduct a detailed and comprehensive study regarding the practice of construction equipment in Ethiopia. And it would enable the governing body, specifically the higher responsible body, and the managements of defense construction enterprise to be aware of the perceived and actual practices of construction equipment management and give insight on how to adopt the different aspects of construction equipment management most effectively and efficiently. It will be also very important for future research in academic purpose by indicating information in regard to different aspects of construction equipment management.

1.10. Organization of the Paper

The paper is organized in to five chapters. The first chapter deals with the paper by providing the basis of the entire research. Chapter two constructs the theoretical frame work of the paper by revising relevant literature. Chapter three presents the methodological and procedural map of the research. Chapters four puts forward the analysis of the data collected. Finally chapter five comprises the summary, conclusions and recommendations of the findings.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Introduction

This literature review is aimed at laying down the fundamental concepts and principles that the research is based upon, and to find out the gaps and limitations in the body of knowledge of construction equipment management.

The study focused on “an assessment of construction equipment management practice in defense construction enterprise in Ethiopia, hence, the literature review accommodates elements of equipment management and is mainly focusing on the core concepts of asset and asset management, and the planning, selecting, purchasing, maintaining, replacement and disposal of construction equipment. In addition to these, views of experts in areas of record keeping and use computers practices, standardization, economics of construction equipment, previous studies on construction equipment management in some other countries, and studies of construction equipment in Ethiopia have been included.

2.2. Concepts of Asset and Asset Management

2.2.1. Definitions Asset

Asset is any material or equipment that has value in its own right. Since the concept of asset is inclusive of wider range of valuables, it is wise in the context of this paper, to take an expertise definition made by Banga and Sharma (2012), he defines asset as ‘any item of economic value owned by an individual or corporation especially that which could be converted in to cash’.

His definition,therefor includes all valuables at hand such as cash ,equipment, real estates, or any other property and those that are not at hand but will be cashed later such as trade marks,patents,copyrights and goodwill. Therefore asset is:

- > Something you own that has value
- > There can be assets that gain value over time....
 - > or lose value over time

2.2.2 Asset Management

Asset Management is one of the integral parts strategic management of physical assets during their life in the organization. Physical assets have a life span; they are planned and created, used, managed and maintained, and when no longer required prepared for disposal.

According to Banga and Sharma (2012) asset management is Maintaining a desired level of service (what you want your assets to provide) at the lowest life cycle cost (best appropriate cost - not no cost),However the main purpose of a Community or Utility is customer service not the management of the assets. We manage assets in order to provide the service!

Asset Management is a tool it can be used to help assure that utility services are provided in a sustainable, cost-effective way in the wider view, PAS 1990, defines Asset Management as

“Systematic & coordinated activities and practices through which an organization optimally manages its physical assets and their associated performance, risks

and expenditures over their lifecycles for the purpose of achieving its organizational strategic plan.”

2.2.3. The Asset Management Function

Asset management activities permeate too many levels of an organization, and are not confined to a central group. For this reason we shall use the term Asset Management Function as a flexible descriptor for the activities involved, and apply the term Asset Manager to those involved significantly, but not necessarily exclusively, in asset management activities (Hinze and Ashton, 1979).

The purpose of the Asset Management Function is to provide resources and expertise to support the acquisition, in-service support and disposal of the physical assets required by the organization. A central asset management function will be needed at company level, providing inputs to asset planning, taking a role in major acquisitions and developments and providing the systems and facilities needed to support assets throughout their life. Asset management is distinct from operations, and does not usually involve the direct design or building of the assets themselves. It is also normally distinct from maintenance, but the technical services functions which support maintenance are part of asset management.

2.2.4. Construction Resource Management

Large amount of construction resources and their scattered locations in a civil construction site make it extremely difficult for project managers to effectively utilize the resources. For this reason, there are strong needs for managing construction resources in a real-time manner (Babu, 2005).

The efficient and effective implementation of construction projects requires good management of relationships for and among resources, activities and stakeholders as applied to the context where such projects are implemented. Materials, Money, Manpower and Machineries (the 4 M's) are usual resources recognized in most situations (Sharma, 1999). For being competitive, companies are working on various strategies to reduce the project costs while improving the profitability. This makes the construction equipment as one of the most critical resources in a construction project. Most CEM

aspects address logical issues of the construction equipment management practices, like equipment selection, financing, maintenance, replacement and management techniques and safety issues. In view of this situation, this review examines the practice of defense construction enterprise construction equipment management system.

2.3. Basic Concepts of Construction Equipment and Construction Equipment Management

2.3.1. Construction Equipment

The concept of construction equipment has been a point of controversy for a long period of time. In its border sense, however, many authors in the field agree that construction equipment, as a construction terminology, refers to all kinds of machinery that are utilized to assist human labor in the field of construction sites.

Studying construction equipment is crucial and vital because the share of equipment cost is very significant in construction project. It is also one of the resource areas in construction that can generate profit if it is utilized efficiently and effectively. According to Sharma (1999, p.34) the cost of equipment in a project varies from 10 to 30% of the total cost of the project, depending upon the extent of mechanization. This statistics indicates that focusing on the investigation of the managerial aspect of such a huge investment needs closer follow up. In addition to this, it should be arguments in the contemporary engineering development to have a closer look at construction equipment because the extent of mechanization in the new technology engineering contexts appears to be mandatory. According to him, the extent of mechanization determines the cost of a project in terms of cost of construction equipment.

In general, construction equipment is one of the most important physical assets in a construction industry. It plays a pivotal role in construction operation and constitutes a major portion of construction projects. In fact according to Tavakoli,Taye and Erktinl, (1989) nearly 50% of the construction firms own the equipment they use. This data informs how construction equipment is given significant place in the world of construction.

2.3.2. Construction Equipment Management Process

Every construction companies should have policies and processes on equipment control & asset management. Equipment control and asset management involves the management of construction equipment within a company. Equipment control begins with the receipt of a newly acquired equipment item and continues through the item's entire life-cycle. Newly acquired equipment should be inspected by in-house or contracted construction equipment Technicians (CETs), who will receive an established equipment control/asset number from the Equipment/Property Manager. The control method can be used to track and record maintenance activities in the database. Once an equipment control number is established, the device is safety inspected and readied for delivery to project areas in the company.

Wireman (1989) emphasis that CEM is a process, which includes that planning, selection acquisition, productivity, maintenance, standardization and quality control cycles. In many cases, however, most of the aspects of this process are either neglected or skipped over. According to researcher's observation, despite the fact that CE is owned and managed by professionals', in frequent occasions managerial process seems to follow traditional CEM practices then scientific conventional approaches.

According to Sharma (1999; p.22) points out that, the "equipment managers main task is to reduce downtime of CE and achieve optimum CE utilization and increase productivity at minimum cost". He also reiterate that "proper planning, selection, procurement, installation operation, maintenance, and replacement "process need to be policy driven an, "have important role in CEM".

According Tatari and Skinnieweski(2006) the following parts focus on the pointes of the process of CEM.

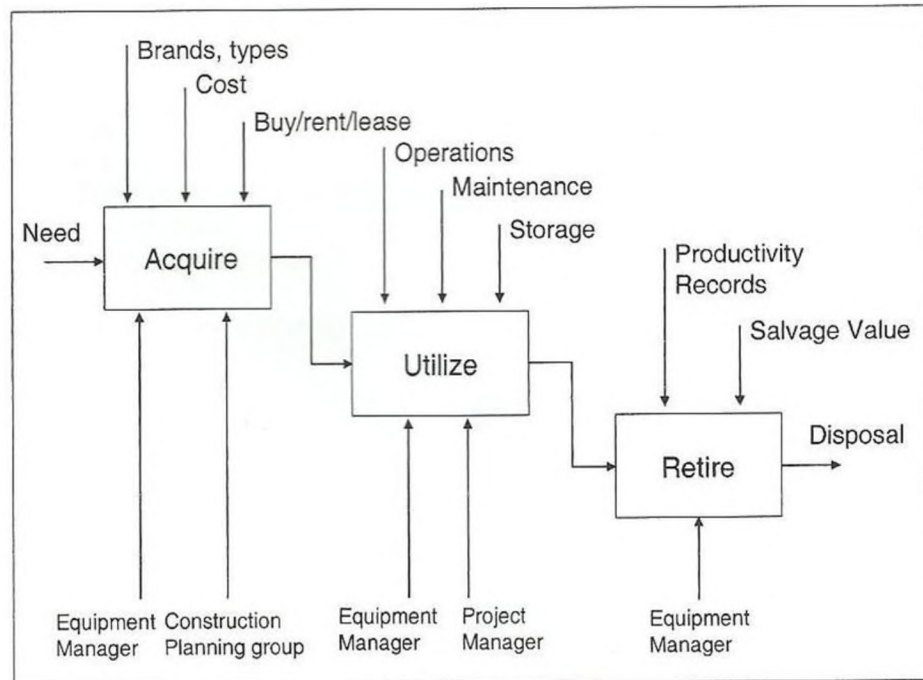
With the undertaking of new projects and the retirement of old machinery and equipment, it becomes necessary to acquire new construction equipment. In this stage, sufficient knowledge base of current brands and products is necessary. It is also important to determine what sort of equipment and capacity is needed. In fact, selection of equipment

for the project is one of the key decisions in planning and executing a construction project, which affects how the work will be done, the time required to complete the work, and the cost that will be accrued.

Generally, an equipment manager is responsible of acquiring the equipment, where as it is the responsibility of the construction planning group to select equipment. Nevertheless, both the inventory of equipment in hand and the standard equipment policy play an important role in equipment selection. Therefore, final decision on the equipment required for the projects is generally given by equipment managers, project managers, and construction planning group together. Often, the decision making process can create tensions in the enterprise. Once the selection of equipment is made, a choice has to be made whether to buy, rent, or lease it. These decisions are given based on the economic standing and strategy of the firm, and the nature and frequency of equipment use.

In operations and maintenance of construction equipment stage, the equipment in use should be maintained properly, by scheduling preventive maintenance periods. Scheduled maintenance reduces the incidents of failure, and thus minimizes costly breakdowns and stoppages on the project site. In construction industry, preventive maintenance has increased the efficiency level of the industry around 10-20%, by reducing the break-down time of the equipment (Moore.W, 1998). For high utilization rates, the equipment should be kept in a good condition. Also, proper selection and training of operators and maintenance personnel is part of the responsibility of the equipment manager. In addition, safety of both the operators and the equipment should be considered and properly managed. Furthermore, proper registration and inventory records are part of the inventory process. Besides the equipment life cycle, equipment managers are also responsible for operating the equipment maintenance and storage facilities.

FIGURE 5: Equipment Management Process



In the retire stage the equipment that no longer attains certain productivity levels should be disposed. In order to decide whether to undertake a major maintenance of the equipment, or to salvage it, productivity and diagnosis records should be analyzed rigorously. Even the salvage of the equipment should bring income to the construction firm. Often times, miscalculations of salvage value may bring losses to the firm.

2.4. Equipment Management Practices in Construction Companies

The cost of equipment in a project varies from 10 to 30% of the total cost of the project, depending upon the extent of mechanization. In modern fully mechanized projects the cost of equipment goes up to 30%. Proper planning, selection, procurement, installation, operation, maintenance and equipment replacement policy plays an important role in equipment management for the successful completion of the project. With the growing use of machinery it has become necessary for construction engineers to be thoroughly familiar with the construction application and upkeep of the wide range of the modern equipment.

Equipment manager's main task is to reduce downtime, achieve optimum equipment utilization and increase production at minimum cost. The cost analysis and the will of adopting proper techniques suited to the situation are the basic factors for the success and therefore, there is a need for a rational planning, proper selection, and judicious deployment of equipment in relation to the conditions so as to achieve optimum utilization. Equipment engineer should coordinate with various wings of the organization in discharging his job of equipment planning, balancing, selection of equipment and its utilization, personnel selection and training, financial planning, preventive maintenance and general supervision. Thus equipment management integrates and continuously interacts with human, technical, financial and production system in order to achieve top efficiency and cost effectiveness.

According O.Tatari and Skibniewski (2006) Construction equipment management is concerned with the purchase, retirement, replacement, operations, logistics, and maintenance of equipment. The objective of the firm is to minimize maintenance, and repair costs, while achieve high utilization of the construction equipment. These responsibilities could be categorized into two groups: operational and strategic responsibilities. Operational responsibilities consist of day-to-day management of construction equipment. Generally, these decisions are given by project managers, who are assigned to specific equipment for specific time by the equipment managers of the firm.

Table.2.1. Operational and Strategic Dimensions of Equipment Management

Operational

Strategic

Maintenance	Planning
Repair	Equipment selection
Operation	Finance/purchase
Record keeping	Replacement
	Disposal

Source, construction equipment audit report, 2006

In most of the construction firms, equipment managers are the sole under takers of the overall responsibility of equipment management. Based on their experience, equipment managers decide on the day-to-day management of equipment operations, and also on strategic operations such as new equipment procurement. Thus, responsibilities of the equipment managers, ensuring that the equipment is properly used, maintained, utilized and managed, are rather challenging. Effective operation of construction equipment should be maintained to avoid underutilization of such large capital investment. Also, preventive maintenance and repair should be carefully planned, and high productivity rates should be realized during operations. As the equipment fleet gets larger, maintaining such goals become a big challenge.

Most construction firms have centralized equipment management function, but actual operations are geographically dispersed. Even though the equipment manager of the firm is the main accountable, responsibilities are shared with project managers that utilize the equipment during project.

2.4.1. Planning Construction Equipment

Equipment planning on major construction projects includes besides its selection, the decision about working shifts, number and size of machines, the matching of units working in a team, procurement schedule and the arrangement of necessary technical staff to operate, service and repair of the equipment. Planning of workshop and store facilities is also an important aspect of equipment planning.

Even though this part of the process of construction equipment management can be accumulated in the acquisition phase, it is such an important part of the process for it determines the basic structure of a project at hand. According to Sharma (1999:p.617), planning Should be, "done with great care, as the efficiency of the whole project largely depends up on its planning" If construction equipment costs up to 30% the total cost of a project , it is very important to exert maximum effort on the planning of equipment.

Planning is an important step, had many points worth according (Moor, 1998) equipment the worth of ordering of the extent of mechanization, equipment planning and execution planning and making decisions accordingly.

With regard to the extent of mechanization Sharma (1999),Mead(1986) identified four important factors. The first one is the availability of manpower. Especially Sharma state, that the availability of cheap labor for adduction of a project may not force the equipment manager to involve in equipment investment, where as expensive managers could lead to investing heavily on equipment. In other words, as Sharma (1999) clearly points it, "the extent of mechanization could be limited on the availability of relatively cheap man power". Mead (1986) also says, "the cheaper the labor cost, the lesser the need for mechanization and, hence, the lesser the cost of inland investment on construction machineries ".

The second factors that determine the map of planning for CE is completion period, some would like to put it, project life. According to Mead (1986), completion period plays a desire role about the extent of mechanization because less completion period entails less mechanization". This means the longer the life of the project, the better the chance of the project managers to depend on human labor, and the shorter the life of the project, the higher the chance of the manager to depend on CE.

The third factors to consider are the nature of the work to be accomplished by the project. At times, Moor (1998),"it is difficult to carry out the project without the use of CE for the work is beyond the scope of human labor to perform".

Most important, as mead puts it is the availability of monetary facility, Sharma (1999; p.615) says: CE planning refers to the use scientific planning techniques to enhance success of the project.

2.4.2. Selection of Construction Equipment

Selection of Construction equipment for a construction project is one of the major functions and decision-making processes carried out by the construction company planning the construction of the project. This is due to the key role in the success of the project played by the selection of the appropriate equipment. Simple, “regular” projects, especially if similar to projects the company has previously built, may not pose a challenge in terms of equipment selection; however, when the project is no longer “regular and definitely in the case of complex and large-scale projects, equipment selection also becomes very complex and challenging. This is due mainly to the following reasons, which should also serve as general guidelines for conducting the selection process:

- > A great variety of makes and models is available for each type of equipment which, by itself, generates a great number of alternatives.
- > Construction companies commonly build several projects concurrently, each requiring its own Equipment planning, and individual equipment plans that look into utilizing equipment owned by the company must be in concert with each other.
- > Feasible equipment alternatives are primarily evaluated and compared on the basis of costs; however, a great many qualitative and intangible factors that are difficult or impossible to quantize must be considered systematically to ensure the selection of a “good” alternative.

Proper selection of equipment for a construction project is vital importance for its speedy and economical completion. Problem of equipment selection has become more complicated, because large varieties of equipment are being manufactured now-a-days. For proper selection of equipment, a considerable experience in the operation and maintenance in the field is essential. Records kept for operation, maintenance and actual output obtained under comparable conditions of previous projects will greatly help in

taking decision for equipment selection (,Sharma,1999). According to him, the Following are the main points which should be considered in the process of equipment selection.

- Suitability for job conditions. The equipment must meet the requirement of the work, climate and working conditions.
- Size of the equipment. Size of equipment should be such that it must be able to be used with other matching units.
- Standardization. It is better to have same type and size of equipments in the project. It means lesser spare parts reserve, more interchangeability of parts if required, easy for the operators to understand it mechanics will be able to maintain and repair better as they become expert by handling similar type of equipment.
- Availability of equipment. The equipment which is easily available in the market should be purchased. It should also be ensured that the equipment is of repute and is likely to be continued to be manufactured in future also. This is necessary for future standardization and ensuring spare parts supply. It is easy to dispose of such equipment after completion of project.
- Availability of spare parts. While selecting a particular type we should be ensured that the spare parts will be available at reasonable price throughout the working life of the equipment. It should also be ensured that the downtime of the equipment for want of spare parts may not be more.
- The economic aspects. While selecting the equipment, it should be considered that the unit cost of production should be as least as possible.
- Reliability of the equipment. Equipment selected for the project must be reliable one.
- Service support. Service support should be available in the area of project where the equipment shall be used. Service after sales is a major criterion for selection of equipment.

- Operating requirements. The equipment selected should be easy to operate and maintain, acceptable to the operator and should have lesser fuel consumption.
- Past performance. If the equipment being purchased is of new make and model, it is desirable to enquire about its performance from other users, who are using this make and model.

According Schexnayder and Shapira (2006) suggest that there are several quantitative evaluation techniques to select the most economical equipment from different alternatives viable in the market. The basic retrain, however, is that there is a demand for a particular type of equipment in the hire market or the machine is simply melded for construction work undertaken by the company needed for construction has been made by the top management to purchase a particular type of equipment the next step should be to carry out an economic evaluation using techniques. Such as payback period method, Accounting return on investment, Internal of return, Next present worth method (or equivalent annual cost method). These techniques use the anticipated cost or both revenues and cost of different equipment alternative in the analysis.

Hinze and Ashton (1997) in practice, not every construction company undertakes the above mentioned economic to select the best optimal equipment. The survey by Hinze and Ashton (1997) shows that one or more of the following criteria are used by contractor to make the decision as to which piece of equipment to buy: always buy the same brand, take the lowest purchase price, service record and regulation of the dealer, the particular needs of the jobs , availability, and best credit terms.

Also there may be other criteria different to those mentioned above, used to select equipment. For example, some companies may look for the dealer's back -up service and good machine performance in addition to the price of equipment (Con.plant and equipment, 1986). Others may prefer to buy the equipment with the longest free warranty period offered by the manufacturer (Mead, 1986).

2.4.3. Construction Equipment Purchase

Once the selection of equipment is done the purchase action for the selected model and type is started considering lead time for the supply of equipment, time required for its installation and commissioning, and the time when equipment should be available for use. The process of selection of equipment is generally a part of procurement, followed by equipment planning and helps in purchase of equipment. The complete procurement action is divided in various activities like calling enquiries, its technical and financial evaluation, ordering, contract-making transporting, assembling, installation and commissioning, and should be followed vigorously, as any delay in any of these activities will result in delay in completion of the project. Therefore these activities are monitored at top most priority.

Generally fast moving or maintenance spares are purchased along with the equipment especially for a period of one or two years. Equipment should be purchased in phases, so that the money is not blocked and equipment required later do not remain idle (Sharma, 1999, p.634)

Purchase of new or used equipment obviously involves large amount of capital. The options available for financing equipment can be given as (Harries and McCaughey, 1997): state through outright purchase, hire purchase, leasing using a finance laces, credit sale or trade or trade credits.

The outright purchase uses funds from retained profits, or from a bank loan which may be either on a short term basis (bank overdraft) or on a long term basis. Under this type of financing the purchaser acquires the title to the machine and the tax benefits (Douglas,1975). Also, the owner could deduct interest on his equipment loan if they had taken such a loan.

In the case of hire purchase, the finance company owns the equipment item, although the user retains control over the way the machine is operated. The user is effectively the owner of the equipment for tax purposes and is cited to claim depreciation and writing

down allowances. In addition, the interest charges are deductible from the taxable income (Higgins and Pe, 2004).

Leasing is a rental agreement which provides all the benefits of the use equipment to the user. However, the leasing company actually owns the equipment and qualifies for the writing down allowances for tax purposes. The user pays an amount that only reflects the above allowances to a certain degree.

A credit sale is a sale in which the purchaser obtains the ownership or the title of the equipment item, but the purchase price is paid in installments (Harries and McCaughey, 1982). These installments usually include the purchase price plus the interest or financial charges on the capital. The owner gets the same tax benefits as in the case of outright purchase.

Once the selection of the equipment is done the purchase order for the selected model and type is issued considering lead time for the supply of equipment, time required for its installation and commissioning and the time when equipment should be available for use. The process of selection of equipment is generally a part of procurement, followed by equipment planning and

Harries and McCaughey, 1982, advise Contractors and other users of construction equipment are required to take a decision as to whether to purchase equipment or to acquire it on hire. The purchase or acquire through hire of equipment decision attempt to take into account the following issues.

- When the equipment is used for the most of the construction period and likely to complete almost its full life, while working in the project.
- It remains available for use whenever it is needed.
- Purchased equipment means an own equipment, is generally kept in better mechanical condition and is more reliable. This means matching equipment will not be affected adversely due to frequent breakdowns.

Beside the followings are also issues to be considered while owning the equipment.

When the equipment cannot be used for its full life, then the owning may be more expensive than hiring.

- The purchaser is required to do huge investment initially, which otherwise he may need for other purposes.
- Contractor may have to face the danger of obsolescence of the equipment.

In this system user hire the equipment at the prevailing rate with a provision that the organization may purchase it at a later date if it wishes to do so. In case it decides to purchase the equipment, a specified portion (generally about 80%) of the hire charges paid shall be adjusted against the original purchase price of the equipment. An agreement, specifying the percentage of hire charges to be adjusted along with other terms and conditions, is made between both the parties. The specified portion allows the previous owner of the equipment to cater for the interest, insurance, taxes etc.

A purchaser may consider buying of used equipment for following reasons.

- The cost of used machinery is substantially less than that of new equipment. Analysis of payback or return on investment reveals that a piece of used equipment is a better buy than a new machine.
- A firm's financial position may dictate so.
- Used equipment is generally more readily available than new equipment.
- Used equipment when adequately satisfies the purchaser's need, and then there is no point in buying new equipment.
- In the event that equipment is needed for standby or peak capacity operation or for use on a short duration project, generally used equipment can satisfy the need very well

As it is difficult to determine the true condition of used machine and to estimate the type and length of service it will provide, it is advisable to engage the services of specialist in the field. If full record of machine is not available, the age of machine can be traced through the manufacturer by serial number identification.

2.4.4. Operation and Utilization of Construction Equipment Management

Since this is the task directly responsible for utilization, maximum managerial care should be given to the 'operation.' Following are an important responsibility for asset managers is to ensure that maximum benefit is derived from their assets. Accordingly, asset managers need to be mindful where, for example, equipment is no longer effective in performing the activities required of it, it is in less than optimum condition, or demand for the services it delivers or supports has reduced.

Underutilized equipment should be identified and the reasons for this examined and, as far as Possible, rectified. The utilization of major equipment items is not monitored on a regular basis. In general, information on equipment utilization is only communicated to hospital management annually when considering equipment replacements and is only confined to those items that were deemed to need replacement. As a result, any potential problems arising from underutilized equipment may not be known by company management.

2.4.5. Equipment Maintenance Practices

Every machine is thoroughly tested and inspected by the manufacturers before selling.

When it is used, it is subjected to wear and tear and hence appropriate and undue attention should be given to protect the machine and its components from undue wear and thus protect them from failures. A proper attention means lubrication, cleaning, timely inspection and systematic maintenance. Maintenance means efforts directed towards the up keep and the repair of that machine. Repair must be done at a time when it may have least disruptions i.e. machine may be repaired when it is not being used or its use may be postponed without affecting the production much. Thus, maintenance is responsible for the smooth and efficient working of an industry and helps in improving the productivity. It also helps in keeping the machine in a state of maximum efficiency and economy (Sharma 2002, p.456).

According to Henze and Ashton(2002) Equipment maintenance is a science because it involves scientific and technical knowhow of different machineries involved, and it is an

art because for identical problem it may require different treatment or action or process. We need equipment for technical and speedy construction and at the same time for economical and timely completion of project.

According to Wireman T. (2001) Maintenance, being an important support function in businesses with significant investments in plants and machinery, plays an important role in meeting this tall order. Consequently, the equipment management has passed through significant changes in the recent times. In the present manufacturing scenario, the maintenance function has become an integral part of the overall profitability of an organization. Every machine is thoroughly tested and inspected by the manufacturers before selling. When used it is subjected to wear and tear, hence proper attention should be given to protect the machine and its components from undue wear and thus protect them from failures. A proper attention means lubrication, cleaning, timely inspection and systematic maintenance. Maintenance means efforts directed towards the up keep and the repair of that machine.

The main purpose of maintenance is to keep the equipment in good, serviceable condition. Therefore, equipment maintenance is a vital function in any contracting or plant hire company. This function includes all the activities such as daily and periodic inspection, lubrication, servicing, repairs and periodic overhauls.

The basic form of maintenance as pointed out by (Harries and McCaughey, 1982):

1. Planned preventive maintenance (PPM),
2. Planned corrective maintenance (PCM),
3. Unscheduled or unplanned maintenance inducing repairs or break down maintenances

2.4.6. Construction Equipment Replacement

Equipment replacement decision plays an important role in the economic running of any concern for years. The reasons for replacement of equipment are: deterioration, obsolescence and inadequacy. The equipment is replaced in order to reduce production cost, to reduce fatigue, to raise quality, to increase output, to secure greater convenience,

safety and reliability. The capital needed for the replacement of the equipment is recovered during its life cycle through depreciation realized every year.

2.4.7. Equipment Disposal

According to Sharma (1999) when equipment becomes obsolete, is not suitable for use for a variety of reasons (damaged, can be used but parts need to be replaced, making it cheaper to buy new equipment, etc.) or is surplus to requirements, there should be a way to dispose of it. Where possible, recycle equipment by giving it to other organizations or individuals in the community who can make use of it as long as it is safe to do so; otherwise it must be destroyed. The recipient must be informed of what needs to be carried with the equipment (e.g. replace a part) before it can be used again, if such action is required before use. Equipment marked for disposal can also be used as a source of spare parts.

For equipment that cannot be repaired and reused, such as slings and slide sheets, a disposal system is needed. Such equipment should be disposed of as recommended by the manufacturers.

2.4.8. Construction Equipment Registration

One of the management tools often used in an equipment maintenance system is an equipment registration and documentation. This registration and documentation can be in the form of a logbook, spreadsheet or customized asset management software. Whatever form it takes, it should allow regular monitoring of essential information regarding equipment location, use and maintenance. Decisions about who makes purchasing or procurement decisions, when equipment should be replaced, and how obsolete equipment will be disposed of, is management planning roles. A construction equipment inventory provides a technical assessment of the technology on hand, giving details of the type and quantity of equipment and the current operating status Popescu and Ryan(2009).

It is important for all organizations that have more than a few items of equipment to develop and maintain equipment registers. Following confirmation of purchase and delivery to a facility, all equipment items should be given a unique number for entry into

the register. In large organizations, the equipment register may be extensive and include a wide range of types of equipment. If there is a combined register of equipment for different purposes, moving and handling equipment should be assigned a specific category, so that all moving and handling equipment can be monitored as a single group. In small facilities a simpler system may be used. Items purchased in large numbers, such as slide sheets and slings, may be entered as groups in the equipment register.

To establish an equipment registration and documentation it is necessary to develop a list of all moving and handling equipment held by the organization or facility.

The equipment registration and documentation is most flexible when created using specialized software. For small organizations with few items of equipment, the register could be developed using existing spreadsheet or database software. Large organizations, where the equipment register contains thousands of items, will most likely acquire or develop customized software. In these organizations, the registers will need to be accessed and updated by multiple users.

Equipment items to enter into the register as a priority should be those that are electrically operated, require scheduled servicing and are used in multiple wards or units. As well as being used to monitor servicing and maintenance requirements, an equipment register is useful for keeping track of the location of equipment and for inventory control for items such as slide sheets and hoist slings.

2.4.9. Construction Equipment Record Keeping

Equipment record keeping is not necessarily limited to maintenance records though maintenance records play an important role in making management decisions. In general, records include operating hours, downtime, costs such as ownership costs, overheads, maintenance and repair operator wages, fuel cost and revenue from equipment.

Douglas(1975) describes the uses the of equipment records as: Analysis of equipment performance, determination of equipment economic life and replacement timing and obtaining true cost of a piece of equipment over its useful life. As mentioned earlier, equipment records are also very useful in making maintenance management decisions

particularly in the areas of preventive maintenance and maintenance resource management (labor requirements and spare parts inventory control).

Equipment record keeping is not necessarily limited to maintenance records though maintenance records play an important role in making management decisions. In general, records include operating hours, downtime, costs such as ownership costs, overheads, maintenance and repair operator wages, fuel cost and revenue from equipment.

2.4.10. Use of Computers in Construction Equipment Management

The computer has become popular among equipment companies in other countries as a mean of keeping and analysis equipment records. Computers are used effectively for various aspects related to the equipment management like, availability of equipment, optimization of equipment, for matching the size of the equipment for matching the size of the equipment with that of other equipment used together for one or related activities, resource level ling, maintenance of history cards and then using them for planning the overhauling of assemblies/ equipment as a whole.

Various problems related to operation research techniques like, queuing models, transportation models etc. as explained earlier can be solved very easily by using computers. CPM/PERT network techniques can be applied for equipment planning, monitoring, controlling, scheduling, and resource allocation purposes through computer. (Sharma, 1999)

2.5. Economics of Construction Equipment

Principles and techniques of engineering economics are utilized while making equipment selection and planning of finances for the purchase of construction equipment. Economics of construction equipment deals with the study of working of the equipment and to compute the unit costs of production. This economic evaluation helps in taking a decision to select equipment or to retire it. Unit cost of production is calculated after estimating the best of production by calculating hourly ownership and operating cost of the Equipment selecting is a decision making from various alternatives which gives least cost of unit production considering various factors of economics being described in this

chapter. It should consider the rate of interest on the equipment, time required completing the project and effect of time on the project, as we know that time is money.

2.5.1. Ownership Costs

The ownership costs are in the nature of fixed costs, as they have to be incurred irrespective of the quantum of use. These are real costs as far as an organization is concerned but they are notional for a site. Ownership costs are fixed costs and almost all of these costs are annual in nature and include:

- a. Investment cost,
- b. Depreciation cost and
- c. Major repair cost

2.5.2. Operating Costs

The operation costs are directly related to the quantum of use and efficiency of the equipment. These costs are normally incurred by the sites and are too apparent and real.

Operating costs of the construction equipment, which represent a significant cost category and should not be overlooked, are the costs associated with the operation of a piece of equipment. They are incurred only when the equipment is actually used. The operating costs of the equipment are also called “variable” costs because they depend on several factors, such as the number of operating hours, the types of equipment used, and the location and working condition of the operation. The operating costs vary with the amount of equipment used and job-operating conditions. The best basis for estimating the cost of operating construction equipment is the use of historical data from the experience of similar equipment under similar conditions. It includes the following costs Cost of fuel (or power), Cost of lubricants, Servicing and maintenance cost, Labor cost, Cost of field repairs (Wireman t., 2001).

2.6. Empirical Studies on Construction Equipment Management Practice

Although few researchers have addressed construction equipment management issue, the majority has concentrated on how to improve productivity via engineering modifications. Very few researchers have paid serious attention to equipment management aspects

(Hinze, 1995). The study by U.S.A Construction Equipment management researcher reported in 1990 major construction equipment problems confronted the construction industry due to the lack of preventive maintenance programs, training and motivating operating and maintenance personnel, influencing standardization and improvement in determining maintenance costs, and poor controlling spare parts inventories. The researcher found, in a follow-up survey conducted in 1991, that most of the problems in this field were people oriented .That is, they are related to the attitude, motivation, training and organization of the personnel related to the equipment. This study concluded that an equipment policy was needed for the unified support of all levels of management.

Stanford University's Construction Institute concurrently surveyed, via personal interviews, firms that had an interest in construction equipment ownership policies. This survey spanned the entire construction industry of the U.S., from dealer to user and from small companies to large. The study recommended that all contractors determine the best policy for their organizations under a given set of circumstances.

Tavakoli (1987) surveyed the construction equipment policies of the top U.S. contractors and concluded that equipment policies sometimes vary between large and medium firms and heavy and non-heavy firms. The survey also indicated the more frequent use of traditional accounting methods over the other more accurate discounted cash flow methods. This finding corroborated the conclusions of a survey conducted on utility contractors by Hinze and Ashton.

Recently, Stewart (1990) addressed equipment maintenance, standardization, and economic life determination. In general, he argued that training equipment operators and automation of management systems will lead to positive improvement to maintenance practices and cost reduction. Stewart presented the monetary and other tangible and intangible benefits generated from equipment standardization. Finally, he presented a method for determining the proper economic life for equipment.

A study by Moor (1999) surveyed construction equipment management practice of contractors of Saudi Arabia. The required data were collected from contractors, via

questionnaires; the survey indicated the selected practice of construction equipment. He concludes that, although only a third of the contractors were found to have documented policies, it was found that there is a uniform practice of management among all the contractors. This indicates that there is a policy for management although it is not properly documented. The fact that contractors claim a gain from the resale of their equipment indicates that the equipment is managed profitably. The main goal of any management policy is to enable optimization of resources and maximization of profits. The management practices of the contractors of Saudi Arabia suggest that the contractors achieve the goals of good management, and they follow the best practice suited to their conditions. Even though there is no written policy with most of the contractors, the implementation of sound principles of management as well as the influence of experience leads to profitable management of equipment.

According to the survey Hinze and Ashton, (1979), Research on equipment management of in construction sector was conducted in Nigeria. The main objective was to investigate factors contributing to construction equipment problems. The research reviewed the processes of equipment planning, procurement, selection, and operation and maintenance management in ten construction institutions. Fifty six questionnaires were mailed to target project managers, equipment managers engineers and technicians in Construction Company in Nigeria.

Several maintenance technicians were interviewed to determine the Effectiveness of the existing construction equipment management practices and processes.

The findings from the data collected revealed that the public maintenance organization does not have proper management of the construction equipment. Private, consultant and contractor maintenance organization have excellent procedures to coordinate and oversee the safe, secure and environmentally sound operations. They also maintain the construction equipment in a cost effective manner which is aimed at long-term preservation of the asset value.

A study (Moor W.,1998) surveyed construction equipment acquisition in heavy construction company of contractors in U.S.A, the required data were collected through

Questioner and he concluded that there is a direct correlation between the size of company and the use capital budgets and equipment policies as decision making tools. Result Further indicates that the chief executive officer is often the decision maker when it comes in equipment acquisition. He added that construction equipment replacement is based on maintenance cost and equipment efficiency.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

Methodology refers to the total sum of techniques of data collection, tool and the methods of analyzing data and theoretical perspective or orientation that govern research. This section provides an overview of research approach adopted in the study which lays within the mixed methods strategies. It discusses research approach adopted and survey design of the study.

3.2. Research Design

Research design is the blueprint for fulfilling research objectives and answering research questions (John A.H. et al., 2007:20-84). In other words, it is a master plan specifying the methods and procedures for collecting and analyzing the needed information. This is to identify and analyze all the elements of phenomenon, processor system such as identification and recording will be done from a particular perspective and often for a specified purpose, However it should always be done as objectively and accurately.

Creswell (2003) identifies three alternative approaches that can be used in conducting a given research. The alternative approaches they identify are quantitative, qualitative and mixed research approach. Quantitative research approach focuses primarily on the construction of quantitative data, and quantitative data is a systematic record that consists of numbers constructed by researcher utilizing the process of measurement and imposing structure (Kent, 2007). The quantitative research approach employ measurement that can be quantifiable while qualitative cannot be measured (Bryman& Bell, 2007). In mixed research approach inquirers draw liberally from both qualitative and quantitative assumptions (Creswell, 2009).

There for the best type of research opted for by the researcher is descriptive approach(mixed approach) which helps the researcher draw assumption from both qualitative and quantitative approaches .This approached is picked because the research aims at describing the existing practice of construction equipment management of defense construction enterprise and comparing it with conventional principles of managing construction equipment.

To assess the practice of construction equipment practice in defense construction enterprise, the researcher used mixed research approach; the rationale for combining both quantitative and qualitative data is to better understand a research problem by combining both numeric values from quantitative research and the detail of qualitative research and to neutralize limitations of applying any of a single approach. According to Creswell (2009) the mixed research approach uses separate quantitative and

qualitative methods as a means to offset the weaknesses inherent within one method with the strengths of the other method should be descriptive research.

3.3. Population and Sampling Techniques

This study has intent to assess the practice of construction equipment management in defense construction enterprise. To do this, the methods employed are survey design. Survey research according to Fowler (1993) is a means of gathering information, usually through self-report using questionnaires or interviews. Its purpose is to generalize from a sample to a population so that inferences can be made and it is also economical and rapid turnaround in data collection (Creswell, 2003).

The populations considered in this study were the number of top middle management members, project managers, construction equipment administration and maintenance case team leaders of head office and projects, and senior technicians in which purposive non probability sampling is adapted to rich evidence. According to the information obtained from human resource development and general service of defense construction enterprise, there are 20 top and middle management, 13 road, dam and irrigation building and real-estate core process managers and 15 case team leaders of construction equipment administration and maintenance support process in projects and head office and 20 senior maintenance technicians a total of 68 sample population were selected.

The sampling technique that this research employed is purposive sampling. Kent (2007) defines Purposive sampling is a sampling technique that allows the researcher pick informants based on the purpose of the study. Of the different types of non-probability sampling techniques, purposive sampling is taken as the most appropriate for the study. This is because of the context of the target enterprise. It is clear that DCE is basically part of a military institute controlled and directed by ministry of national defense (MoND). Therefore, naturally, its projects are widely dispersed across the border of the country. This makes it very difficult to reach all the projects and complete the research project within a given period of time. Therefore, it is preferable to reach projects and offices of the enterprise based on purposive sampling in terms of transportation and other facilities.

In the case of this paper, of the employees working in the enterprise were selected as participants based on their involvement in construction equipment management practice and their availability.

3.4. Type of Data and Collection Instruments/tools

The study used both primary and secondary data. Here there are two basic sources of data sources namely, primarily and secondary source, in this study both primary and secondary sources of data was utilized through questionnaires, interview and literature review, observation check list & flows group discussion guide, etc. Primary sources of data include interview and questionnaire, these questionnaires and interview were composed of both open ended and closed ended items, whereas secondary sources data were generated through a review of relevant documents.

Questionnaire

In order to realize the target, the study used well-designed questionnaire as data collection instrument. Questionnaires were distributed top and middle management members, project managers, construction equipment administration and maintenance case team leaders of head office and projects, and senior technicians. They were selected as respondents because they are deemed to be knowledgeable about construction management practice and could provide important perspective on its adoption. The response is expected to help understand the factors that could explain the practice of construction equipment management as case of defense construction. The research evidence was gathered by using both close-ended and open-ended questionnaires. Mixed questionnaires have many merits; the most important of this advantage is its considerable flexibility (McNabb, 2005). The questionnaires were structured based on those used by Iyoha and Faboyede (2011), and Sharif (2010). With regard to the close-ended questions, the respondents were asked to indicate their level of agreement on a five point Likert scale with the following ratings. Strongly agree (SA; or 5), agree (A; or 4), neutral (N; or 3), disagree (D; or 2), and strongly disagree (SD; or 1). On this

scale a score of 5 or 4 indicates that the item is perceived to be essential while a score of 3 or 2 indicates that the item is perceived to be fairly important, but not essential, while a score of 1 indicates that the item could be disregarded for being unimportant. Similar scales have been used by Courtis (1992) and Iyoha and Faboyede (2011) and were found suitable. With respect to the open ended questionnaires the respondents were asked to provide open ended responses to the questions that require opinion and if they have opinions they feel the researcher would find useful.

Interview

Semi structured interview with middle management members, project managers, construction equipment administration and maintenance case team leaders were conducted. It allowed the investigator some degree of flexibility at the time of interviewing for the pursuit of unexpected line of inquiry which was arising at the study progresses. Questions in the interview checklist were constructed based on the review of literature. In the process of preparing, testing and using the instruments, the following procedures have been followed.

- > The questionnaires and the interview guides were developed based on literature review relevant to the issue and the specific objectives.
- > Both tools were judged for their validity using professionals in the area.
- > In the final study, the questionnaires and interview were administered both by the researcher.

Document Review

The review of documents helped the researcher to understand the key facts of the organizations. The documents were reviewed by referring most recent information from authorized documents and different reports. Annual performance reports and other documents related to the equipment management were used. The document reviews were used to triangulate the data collected by the questionnaires and interviews.

3.5. Procedure of Data Collection

In order to assess CEM practices in the enterprise data was collected from primary and secondary resources. In case of primary resources, first we select & categorize target groups

and preparing survey questionnaires & submit interview /discuss with the target group & finally collect the filled questionnaires from the respondents, on the other hand in the secondary data, we collected data from writer reports & publication of SAE, project reports, documents, articles, journals, books, internet sources & other related sources by selecting the document we will use it.

3.6. Methods Data Processing and Analysis

As explained in the preceding part, the research is designed to follow a mixed method. To this end, both qualitative and quantitative analyses were used. Data collected using questionnaire was analyzed through descriptive statistics, frequency distribution using Statistical Package for the Social Scientists (SPSS). It helps to describe what the data look like, where there center (mean) is, how broadly they are spread in terms of one aspect to the other aspect of the same data (Leedy, 1989). The SPSS version 21 is used to find out percentages, mean values, frequencies, correlations, etc. as main means for summarizing the data. Data collected from the interview and reviews of documents are interpreted qualitatively. In analyzing the data from interviews, narrative approaches including quotations from respondents have been used.

CHAPTER 4

Results and Discussions

4.1. INTRODUCTION

This chapter explains and discusses the results of findings based on the analysis done on the data collected. The results of the study are discussed by triangulating the different sources results: questionnaire results, interview and document review results. The

discussion attempts to accomplish the objectives of the study and answer the research questions.

A total of 68 questionnaires which dealt with construction equipment management practice and other aspects were distributed to the respondents of the enterprise. However, only 65 questionnaires were collected and had usable responses (95.4% response rate), interview and relevant documents have been also reviewed. Considering the difficulty of collecting data in construction company projects, especially DCE, a (95.4%) response rate was reasonably very good.

The questionnaire contains variables which include issues such as construction equipment policy, guidelines and procedures, budgeting, investment, selection, purchasing decision ,maintenance, record keeping, replacement and rent determination and disposal options. All items in the questionnaire are arranged in a form of Likert items to capture the feelings of respondents in scales ranging from 1 to 5.Five being the strongest possible feeling and 1 being the strongest possible negative feeling. All the data has been include in the SPSS so that the accuracy of the information is maintained.

In additions to this, interview was conducted among the top and middle level managers. The contents of the interview are manipulated in a way that it would prove or disprove the feeling exposed by the participants who responded to questionnaire. All the interview questions were structured so that they match the contents of the items enlisted in the questionnaire.

An attempt has been made in the analysis to integrate and align the information obtained from questionnaire, interview, and other relevant document.

4.2. General Information about Respondents

Table 4.1 shows general information about sex, education qualification, work experience, and job position of respondents. Most (81.5%) of respondents are male and only 18.5% are of female respondents.

Table 4.1.General Information about Respondents

Variable	Frequency	Percentage
Sex		
Female	12	18.5
Male	53	81.5
Total	65	100
Educational qualification		
MA\MSC	5	7.7
BA\BSC	42	64.6
Diploma	16	24.6
Below diploma	2	3.1
Total	65	100
Work experience		
Less than 5 years	7	12.8
5-10 years	13	20
11-15 years	32	49.2
Above 15 years	13	20
Total	65	100
Job position		
Top management	5	7.7
Middle management	15	23.1
Project management	13	16.9
Equipment administration case team leaders and senior technicians	20	30.8
Total	65	100

Source: *Own Calculation*

Majority (64.6%) of respondents has an educational qualification of first degree and followed by diploma holders which accounts 24.6%. only 7.7% and 3.1% are second degree and diploma holders respectively.

It can be seen from table 4.1 above that majority (69.2%) respondents have a work experience of more than ten years and the rest (32.8%) have a work experience of less than ten years.

Finally when we look at job position of respondents, most (30.8%) of respondents are senior technicians (electrical and mechanical), middle management (23.1%), and equipment administration and maintenance case team leaders (21.5%). It can also be seen from above table that 7.7% and 16.9% of respondents are top management and project managers respectively. Two project managers and one equipment administration and maintenance case team leader were unable to fill and return the questionnaire on time owing to the remoteness of projects location.

4.3. Construction Equipment Policy

An equipment management policy is a set of procedure for setting the framework for managing equipment. It enhances and improves effective communication within an organization.

Table 4.2: Construction Equipment Management Policy

No	Variable	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The enterprise has written guidelines, procedure and manuals to manage construction equipment	4.2	0.5	-	-	2(3.1%)	50(76.9%)	13(20%)
2	The enterprise guideline, procedure and manuals are clear and easily understandable	1.9	0.7	19(29.2%)	37(56.9%)	8(12.3%)	1(1.5%)	-

Source: Own Calculation

From survey result (Table 4.3) majority (76.9%) of respondents agreed that as the enterprise has written guidelines, procedure, and manual to manage construction equipment. However, most of respondents (86.1 % with mean response 1.9 and standard deviation of 0.7) stress that the prevailing guideline, procedure and manuals are not clear and easily understandable. The interview result also suggested that existing equipment policy manual did not cover various aspects of equipment management.

4.4. Construction Equipment Budgeting (Planning)

Two important factors were set to check whether the enterprise prepared annual equipment budgeting and whether it uses standard forms for the capital budgeting purposes.

Table.4.3.Descriptive Statistics Equipment Budgeting (Planning)

No	Variable	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The enterprise prepared equipment budgeting every year	4.1	0.7	-	2 (6.5%)	1(3.2%)	20 (64.5%)	8 (25.8%)
2	The enterprise uses standard forms for equipment budgeting request	3.23	0.9	1(3.2%)	5 (16.1%)	12(38.7%)	12 (38.7%)	1 (3.2%)

Source: Own Calculation

The majority (about 90%) of respondents agreed that the enterprise prepares short and long range capital budgeting for acquiring construction equipment. It was revealed by the interview that the enterprise appreciates budgeting planning for augmenting its capacity and become competitive in the construction sector. However, respondents neither agreed nor disagreed on the use of standard forms for capital budgeting purpose by the enterprise.

4.5. Construction Equipment Investment

Firms make capital investment to increase their capability and there by sustain profitability in the ever dynamic global business environment. Capital investment

decision is made at high level of risks; it must be done in most effective manner to possible future returns (Harris and McCatter, 1982).Accordingly, respondents were asked to indicate the various aspects to be considered in equipment investment decision in the enterprise.

Table.4.4.Descriptive Statistics Construction Equipment Investment

NO	Variable	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Construction equipment investment proposal is initiated at head office	4.39	0.8	-	2 (6.5%)	-	13 (42%)	16 (51.6%)
2	Construction equipment investment proposal is initiated by equipment and maintenance support process	3.16	1.5	2 (6.5%)	15 (48%)	1 (3.2%)	2 (6.5%)	11(35.5%)
3	Project managers initiate equipment investment	1.97	0.3	2 (6.5%)	28 (90%)	2 (3.2%)	-	-
4	Qualitative and quantitative method of evaluation is adopted to analyze investment proposal	1.81	0.8	11(35.5%)	17 (55%)	3 (3.2%)	2 (6.5%)	-
5	Qualitative and quantitative method of evaluation is adopted to determine the selection of investment proposal	1.77	0.8	12 (39%)	16 (52%)	4 (3.2%)	2 (6.5%)	-

Source: *Own Calculation*

The acquisition of new equipment start with identification for its need somewhere in the organization and from above table 4.5 it follows that majority (94% with mean response 4.9 and standard deviation of 0.8) of respondents agreed as equipment investment proposal is assumed to be originated from head office and construction equipment administration and maintenance support process play a vital role as it is charged with responsibility of identifying and providing the needs of equipment to projects, and most (90%) of project managers have little to do with in the initiation of equipment.

Once the equipment investment initiation is approved the next is to identify alternatives to satisfy the identified needs. The survey result indicates that the majority (90% and

91%) of respondents disagreed as the enterprise makes and adopts quantitative and qualitative method to analyze and select alternatives to investment proposals.

4.6. Construction Equipment Selection

Survey result shown (table 4.6) reveals that most (74% with mean response 3.7 and SD 1.3) of respondents agreed as the enterprise uses internally developed technical and financial criteria to select construction equipment in that case, least price as prime criteria, top management decision, and equipment standardization as technical criteria are presented in the selection process. This was confirmed by findings of (Hinza and Ashton, 1997) that several quantitative and qualitative techniques to select the most economical equipment from different alternatives available in the market. The basic criterion, however, is that there is a demand for a particular type of equipment in the market or the machine is simply needed for construction work undertaken by the company. Once the decision has been made by top management to purchase a particular type of equipment the next step should be to carry out an economic evaluation such as payback period, accounting return on investment, internal rate of return, always buy the same brand, take the lowest purchase price, service record and reputation of the dealer, the particular needs of jobs, availability, etc.

Table.4.5. Descriptive Statistics Construction Equipment Selection

NO	Variable	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The enterprise uses internally developed technical and financial criteria	3.71	1.3	3 (9.7%)	4 (12.9%)	1 (3.2%)	14 (45.2%)	9 (29%)
2	Least price criteria	3.32	1.0	1 (3.2%)	7 (22.6%)	5 (16.1%)	17 (54.8%)	1 (3.2%)
3	Equipment selection is determined by management	3.68	1.0	-	6 (19.4%)	5 (16.1%)	13 (41.9%)	7 (22.6%)
4	Equipment selection is determined based on equipment standardization	3.1	1.0	1 (3.2%)	10 (32.3)	5 (16.1%)	15 (48.4%)	-
5	equipment selection is based on the past experience and information of other users	2.68	1.2	7 (22.6%)	7 (22.6%)	6 (19.4%)	11 (35.5%)	-

Source: *Own Calculation*

It could also, however, be seen that respondents (with mean response 2.68 and SD 1.2) neither disagreed nor agreed on the utilizations of past experience and information of other users by the enterprise while selecting equipment.

4.7. Construction Equipment Purchase Options

Table below indicates purchase options that can be applied in equipment purchase decision. Most (64.5% with mean 4.03 and standard deviation1) of respondents agreed that the enterprise uses outright purchase to finance equipment purchase. The survey conducted by (Douglas, 1975) pointed out the benefit of outright purchase in that it indicated under outright purchase the purchaser acquires the title to the machine and tax benefit. For example, a company is entitled to deduct depreciation on the equipment as an expense of doing business. Also owner could deduct interest on his equipment loan if it had taken such a loan.

Table 4.6 Descriptive Statistics Construction Equipment Purchase Options

NO	Variable	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Hire purchase is adopted in the enterprise	2.6	1.3	9 (29%)	7 (22.6%)	2 (6.5%)	13 (41.9%)	-
2	Outright purchase is common in the enterprise	4.0	1.0	1 (3.2%)	8 (25.8%)	1 (3.2%)	20 (64.5%)	-
3	Leasing using a finance lease	2.1	1.0	4 (12.9%)	18 (58.1%)	3 (9.7%)	4 (12.9%)	
4	Credit sale	3.7	1.1	-	8 (25.8%)	-	16 (51.6%)	7 (22.6%)
5	Others methods	2.8	1.3	7 (22.6%)	8 (25.8%)	-	16 (51.6%)	-

Source: *Own Calculation*

As it can also be depicted from the above table, 74% of respondents agreed with credit sale are the next purchase option employed by the enterprise. Findings undertaken by (Harris and McCatter, 1982) described the importance of credit sale in that purchaser acquires the ownership or the title of equipment item but the purchase price is paid in installments. The installments usually include the purchase price plus the interest or financial charges on the capital. The owner gets the same tax benefit as in case of outright purchase. According to (Mead, 1996), outright purchase and credit sale are the most widely used financing mechanism to equipment purchase. It is also revealed in survey that leasing a finance lease (with mean response 2.1 and SD 1.0) and hire purchase (with mean response 2.6 and SD 1.3) has little to do in financing equipment purchase in the enterprise.

4.8. Construction Equipment Maintenance Practice

The main purpose of maintenance is to keep the equipment in good serviceable condition and equipment maintenance is a vital function in any contracting company. This function includes all activities such as daily and periodic inspection, lubrication, servicing, repairs and periodic overhaul.

Table.4.7. Descriptive Statistics Construction Equipment Maintenance Practice

NO	Variable	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The enterprise has well organized and integrated maintenance system	2.4	1.2	16 (24.6%)	31 (47.7%)	14 (21.5%)	4 (6.2%)	-
2	Corrective type of maintenance is practiced in the enterprise	3.4	1.1	2 (3.1%)	19 (29.2%)	1 (1.5%)	39 (60%)	4 (6.2%)
3	Unscheduled type of maintenance is practiced in the enterprise	3.3	1.3	14 (21.5%)	3 (4.6%)	1 (1.5%)	44 (67.7%)	3 (4.6%)
4	Preventive type of maintenance is practiced in the enterprise	2.5	1.4	23 (35.3%)	24 (36.9%)	1 (1.5%)	10 (15.3%)	7 (10.7%)

Source: *Own Calculation*

The respondents were asked to indicate the type of maintenance activity undertaken in the enterprise equipment and how it is organized. As indicated in table 4.8, most of respondents (72% with mean 2.4 and standard deviation) disagreed with the existence of well-organized and integrated maintenance system in the enterprise. This was also confirmed by interview result made with top and middle management of the enterprise; they assert that because of lack of integrated and well organized maintenance most of equipment in road projects is frequently breakdown and heavily affected the performance of road project schedule. It is also indicated in the survey most (66.2% with mean response 3.4 and SD 1.1) of respondents agreed corrective type of maintenance is mostly practiced in the enterprise.

Another aspect of maintenance practiced by the enterprise is unscheduled maintenance. Survey carried out by (Douglas, 1975) suggested some maintenance activities such as essential lubrication are performed at unspecified intervals and repairs are undertaken

only when a machine is broken down. However, repair may also be done on a machine when a component is malfunctioning and the mechanical performance of the machine is unacceptable. An unexpected failure of machine can occur at any time and unscheduled maintenance (repair) in such case is unavoidable. It was also able to see in the survey most (71.3% with mean 3.3 and SD 1.3) of respondents agreed with unscheduled maintenance is highly practiced in the enterprise.

It can also be seen that from table 4.7 that preventive maintenance practice is assumed to be low (72.3% with mean 2.5 and SD 1.4) and this was consolidated through interview made with top and middle management of the enterprise. They indicated that because of the lack of preventive maintenance practice in the enterprise equipment develops matured failure. They also suggested undue attention should be given to improve the practice of preventive maintenance to construction equipment if the enterprise is to improve the accomplishments of construction projects as per their schedule. As finding of (Tucker, 1980) pointed out the role of preventive maintenance to organization: 'Prevention is better than cure'. It includes inspection, adjustment, or tightening routines of equipment components at prescribed interval in order to prevent any premature failure.

4.9. Construction Equipment Replacement Factors

Seven replacement factors were distributed to respondents to assess and examine the decision concerning the replacement of equipment. Like any other equipment, a piece of construction equipment deteriorates with use. As a result, the maintenance costs increases and the equipment becomes less reliable. The reliability is a measure of the frequency of unexpected breakdown of equipment. A less reliable old piece of equipment would usually have a higher breakdown rate than that of new equipment. The consequences of these breakdowns are disruption to the construction work for which the equipment is being used and this in turn causes direct or indirect monetary losses to the equipment company. Therefore, contracting and plant hire companies should replace their old equipment regularly after a numbers of years of ownership (N.D.Gunawardena, 1998).

Table 4.8.Descriptive Statistics Equipment Replacement Factors

NO	Replacement Factors	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Maintenance and repair cost	3.8	1.2	7 (10.8%)	4 (6.2%)	1 (1.5%)	38 (55.8%)	15(23.1%)
2	Down time cost	4.2	0.5		1 (1.5%)		51 (78.5%)	13 (20%)
3	Depreciation	2.9	1.1	10 (15.4%)	17 (26.2%)	11(16.9%)	27 (41.5%)	-
4	Inflation	2.5	0.9	9 (13.9%)	27 (41.5%)	19(29.2%)	10 (15.4%)	-
5	Obtainable resale value	2.3	1.0	14 (21.5%)	35 (53.8%)	2 (3.1%)	14 (21.5%)	-
6	Obsolesce	4.2	0.8	-	2 (3.1%)	10 (15.4%)	28 (43.1%)	25(38.5%)
7	High cost of investment	3.2	1.1	-	30 (46.2%)	-	28 (43.1%)	7 (10.8%)

Source: *Own Calculation*

The survey result (shown in table 4.8) indicated that majority of the respondents agreed down time cost (78% with mean response 4.2 and standard deviation 0.5), maintenance and repair cost (55.8% with mean response 3.8 and standard deviation 1.2), and obsolescence (with mean 4.2 and standard deviation 0.8) were identified as major factors in influencing equipment replacement decision. It was also found that respondents were neither agreed nor disagreed that the high cost of equipment investment influence (with mean 3.2 and standard deviation 1.1) equipment replacement decision. Inflation (with mean 2.5 and standard deviation 0.9) and obtainable resale value (75% with mean response 2.3 and SD 1.0) were to be less influential in replacement decision of equipment.

4.10. Construction Equipment Replacement Time Determination

Construction equipment replacement is a continuous process, therefore the major consideration is “when to replace” but this when requires many considerations to each at suitable conclusion. Large numbers of factor are responsible to replace the construction equipment before the expiry of the estimated life.

Respondents were asked when the enterprise would make the actual decision to replace equipment. A majority (60% with mean 3.5 and standard deviation 1.5) of respondents said that the enterprise would replace equipment when equipment is obsolete and adopt experience and informal analysis (with mean 3.4 and standard deviation 1.3) for replacement decision

Table.4.9.DescriptiveStatistics of Construction Equipment Replacement Time Determination

NO	Equipment Replacement Time Determinant	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The enterprise makes economic analysis to replace equipment	1.9	0.8	19 (29.2%)	36 (55.4%)	7 (10.8%)	3(4.6%)	-
2	The enterprise replaces equipment when they are inefficient	2.4	1.2	13(20%)	30(46.2%)	7 (10.8%)	11(16.9%)	4(6.2%)
3	The enterprise replaces old equipment before new project is hand over	2.3	1	13(20%)	32(49.2%)	7 (10.8%)	13(20%)	-
4	The enterprise replaces equipment before major overhaul	1.9	0.8	18(27.7%)	36 (55.4%)	8(12.3%)	3(4.6%)	-
5	The enterprise replaces equipment when it is obsolete	3.5	1.2	1(1.5%)	22(33.8%)	2(3.1%)	26(40%)	14(21%)
6	The enterprise uses formal economic analysis for construction replacement decision	1.8	0.6	18(27.7%)	45(69.2%)	-	2(3.1%)	-
7	The enterprise uses experience and formal analysis for construction equipment replacement decision.	1.7	0.6	24(39.9%)	39(60%)	-	2(3.1%)	-
8	The enterprise uses experience and informal analysis for replacement decision	3.4	1.3	29(44.6%)	-	-	16(24.6%)	20(30.8%)

Source: Own Calculation

On other hand, respondents disagreed with the enterprise replaces equipment when it is inefficient (with mean 2.4 and standard deviation 1.2), before major overhaul (with mean 2.3 and standard deviation 1), and before new project is handover (with mean 2.3 and standard deviation 0.8). It is also revealed by survey as the enterprise does not adopt formal economic analysis (with mean 1.8 and standard deviation 0.6) and experience and formal analysis (with mean 1.7 and standard deviation 0.6) for equipment replacement decision.

4.11. Disposal of Construction Equipment

Respondents were asked on the way how the enterprise disposes old equipment that are cease to function economically. Equipment is usually disposed after its optimum use by either trading it off for new equipment or by selling it to other smaller contractors.

Table.4.9.Disposal of Construction Equipment

NO	Equipment Disposal Mechanism	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	DCE trades construction equipment to dealers	1.7	1.0	3 (9.7%)	17(54.8%)	6(19.4%)	-	-
2	The enterprise disposes construction equipment through auction sale	1.3	0.8	10 (32.3%)	15(48.4%)	1(3.2%)	-	-
3	The enterprise disposes construction through third party	1.9	1.1	3 (9.7%)	13(41.9%)	8(25.8%)	2 (6.5%)	-

Source: *Own Calculation*

Survey result (in table 4.11) indicated that respondents disagreed with existence of any of aforementioned disposal mechanism. This proposition was also confirmed by interviews of top and middle management members; they asserted that it is true there are numbers of equipment that need to be disposed by the enterprise; however due to the lack of clear equipment disposal mechanism, it has not been able to dispose those old equipment. They also suggest the enterprise should develop and implement old equipment disposal mechanism if it is to know overall economically functioning equipment and to make further investment decisions in the future.

4.12. Challenges of Equipment Management

There were nine questions under challenges of construction equipment management practice. It was able to see that unavailability of spare part identified as major challenges (with mean 4.5 and standard deviation 0.8) faced by the enterprise in managing equipment. According to interview result, lack of equipment standardization practice in the enterprise and unavailability of strong and competent spare part suppliers in the country are two major causes for unavailability of spare part problem.

Table.11.Challenges in Practicing Construction Equipment Management

N O	challenges	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The high cost of construction equipment management system	2.8	1.0	1 (1.5%)	34(52.3%)	8 (12.3%)	21(32.3%)	1 (1.5%)
2	Lack of experience in managing construction equipment	3.5	1.0	1 (1.5%)	13 (20%)	10(15.4%)	33(50.8)	8(12.3%)
3	It is complex task	2.7	1.4	16(24.6%)	20(30.8)	2(3.1%)	19(29.2%)	7(10.8%)
4	Lack of skilled manpower in the filed	3.3	1.2	7(10.8%)	14(21.5%)	1 (1.5%)	41(63.1%)	2(3.1%)
5	Lack of construction equipment implementation guideline and procedure	2.7	0.9	-	36(55.4%)	14(21.5%)	14(21.5%)	1 (1.5%)
6	Lack of well-established IT system to manage equipment	4.2	0.7	-	4(6.2%)	1 (1.5%)	40(61.5%)	20(30.8)
7	Unavailability Training development	3.9	0.8	-	4(6.2%)	14(21.5%)	32(49.2%)	15(23.1%)
8	Location of projects and unfavorable weather condition	2.8	1.3	16(24.6%)	15(23.1%)	1 (1.5%)	33(50.8%)	-
9	Unavailability of spare parts	4.5	0.8	-	3(4.6%)	1 (1.5%)	21(32.3%)	40 (61.5%)

Source: *Own Calculation*

Likewise, it was also found in the survey result lack of well-established information technology (91.3% with mean response 4.2 and SD 0.7), unavailability of training

development (72.3% with mean response 3.9 and SD 0.8, lack of experience in management of construction equipment (64.2% with mean 3.5 and SD 1.00, and lack of skilled man power in the field (66.2% with mean 3.3 and SD 1.2) were indicated as deterring factors for effective and efficient management of construction equipment in the enterprise.

Respondents were neither agreed nor disagreed with the negative impacts of high cost of construction equipment management system, complexity of equipment management, and location of projects and unfavorable weather condition on the management of equipment in the enterprise.

4.13. Rent Determination

An attempt was made to solicit information through survey concerning the mechanism how equipment rent is determined in the enterprise. Hence, respondents disagreed with the enterprise determination equipment rent based on own data base (with mean response 2.5 and SD 1.3) and government rate (with mean response 2.2 and SD 1.1), and standard publication (with mean response 1.9 and SD 1.1). According to interview result, respondents indicated that the enterprise did not have responsible unit that can organize and use internal and external updated information regarding equipment rent. It is also suggested as there is no responsible government body that can determine construction equipment rent in Ethiopia; only market itself determines the level of rent in the construction sector.

Table.12.Descriptive Statistics for Rent Determination

NO	Rent Determination Method	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Equipment rent is determined based on enterprise's own data base	2.5	1.3	8(25.8%)	11(35.5%)	-	12 (38.7%)	-
2	Equipment rent is determined based on government rate	2.2	1.1	10(32.3%)	12 (38.7)	3(9.7%)	6 (19.4%)	-
3	Equipment rent is	1.9	1.1	14(45.2%)	3 (9.7%)	12(38.7%)	1 (3.2%)	-

	determined based on standard publication							
4	Equipment rent is determined based on other similar construction company experience	3.0	0.9	-	12 (38.7)	8 (25.8%)	11 (35.5%)	-

Source: *Own Calculation*

Also, as in table 12, respondents (with mean response 3.0 and SD 0.9) neither agreed nor disagreed whether the enterprise determines equipment rent based on other similar construction company experience. This was confirmed with interview result; respondents indicated as there was no formally organized and integrated mechanism to use other similar construction company experience to determine equipment rent in the enterprise

4.14. Construction Equipment Standardization

One of the most important aspects of heavy construction equipment policy is equipment standardization. Respondents were asked to express their view on the benefit of standardizing construction equipment. As shown in table 13 below, majority of respondents (70% with mean response 4.2 and SD 0.6) agreed with standardization could save spare part availability. This was also confirmed by Magesa.B and Marcelin.B (2006) findings. According to them, poor maintenance of management of construction equipment owned by company is the multiplicity of different types, makes, models and usage of different machine. This causes problems in servicing of the equipment due to requirement of multiple numbers of spare parts and skilled mechanics and operator. In order to reduce this problem, contractor should standardize on one or few makes and models.

Table.13.Descriptive Statistics in Construction Equipment Standardization

NO	standardization benefits	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Standardizations can save spar part availability	4.2	0.6	1 (1.5%)	-	1(1.5%)	46(70.8%)	17(26.2%)
2	Standardizations can lower maintenance costs	4.0	0.5	-	-	7(10.8)	49(75.4%)	9(13.8%)
3	Standardizations can bring better performance of the enterprise	4.0	0.6	-	1 (1.5%)	10(15.4%)	41(63.1%)	13(20%)
4	Standardizations can make ease for CE management issues	4.1	0.6	-	-	13(12.3%)	40(61.5%)	17(20%)

Source: *Own Calculation*

The survey result (as indicated in table 14 above) also indicated that most of respondents (75.4% with mean response 4.0 and SD 0.5) agreed that standardization can bring lower maintenance costs, better organizational performance (63.1% with mean response 4.0 and SD 0.6), and enhance easier equipment administration (61.5 with mean response 4.0 and SD 0.5).Likewise, the interview result asserted in addition to aforementioned benefits, standardization can also lower operator cost, improve safety, and better supplier relationship.

4.15. Construction Equipment Record Keeping

Six questions were distributed to respondents to examine equipment record keeping practice and result (in table 14 below) indicated that respondents disagreed with the proper equipment utilization record (66.1% with mean response 2.8 and SD 1.2),daily report record by operator (64.6% with mean response 2.7 and SD 0.9), and timely equipment utilization report (5.5% with mean response 2.2 and SD 0.9), equipment costs record (60% with mean response 2.4 and SD 1.0), and maintenance data and costs record (60% with mean response 2.4 and SD 1.0) is practiced at both head office and project level. Interview result also suggested that there was equipment record keeping in the enterprise. However, because of lack continuous monitoring and follow up ,and remedial course of actions by head office and projects, equipment utilization ,daily report by

operator, timely equipment utilization report, equipment costs and maintenance data and costs records are not properly undertaken in appropriate manner.

Table.14.DescriptiveStatistics of Construction Equipment Record Keeping

NO	Equipment Record Keeping Practices	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	Equipment utilization record is properly maintained both at head office and projects	2.8	1.2	6(9.2%)	39(66.1%)	6(9.2%)	8(13.5%)	6(9.2%)
2	Operator record daily report	2.7	0.9	4(6.2%)	42(64.6%)	12(18.5%)	7(12.3%)	-
3	Equipment utilization report is filled timely	2.2	0.9	12(18.5%)	38(58.5%)	6(9.2%)	9(13.8%)	-
4	There is an appropriate method of data recording	2.3	1.0	12(18.5%)	35(53.8%)	5 (7.7%)	13(20%)	-
5	Construction equipment costs are recorded properly	2.4	1.0	5 (7.7%)	39(60%)	5 (7.7%)	14(21.5%)	-
6	Maintenance data and costs are recorded properly	2.5	1.0	4(6.2%)	39(60%)	6(9.2%)	15(23.1%)	

Source: *Own Calculation*

Also the survey result indicated that respondents (with mean response 2.3 and SD 1.0) disagreed with the existence of appropriate manual and computer based method of data recording to equipment. As N.D. Gunawrdena (2000) pointed out the role of computer based record keeping. According to him, computer has become popular among equipment companies as a means of keeping and analyzing equipment records and suggested that computer may be applied to equipment management in areas of basic accounting or book keeping, management accounting and information including: acquisition and disposal analysis, revenue and cost record, plant utilization, stock control and maintenance records, and financial appraisal of equipment. According to interview result, currently there exists manual based equipment record method in the enterprise. But it is not effective and efficient in producing all the necessary information that can be further analyzed and used for decisions making process. Computer based equipment management needs to be in place so that the enterprise can easily keep and analyze equipment records.

4.16. Construction Equipment Monitoring and Controlling

There were four questions distributed to respondents in relation with equipment monitoring and controlling mechanism practice of the enterprise. Majority of respondents (72.3% with mean response of 3.9 and SD 0.8) as indicated in table 15 below agreed with the enterprise has inventory system to manage equipment. However, most (58.5% with mean response 1.5 and SD 0.6) disagreed with effectiveness and efficiency of inventory system. As per the interview result, respondents indicated that inventory system is set upon manual base and difficult to take timely inventory, generate all relevant data, and produce reports about equipment. They suggested that the enterprise should adopt computerized inventory management system if it is to make timely inventory, generate necessary data and produce timely report about equipment.

Table.15.ConstructionEquipment Monitoring and Controlling

NO	equipment monitoring and controlling aspects	MN	SD	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1	The enterprise has construction equipment inventory system	3.9	0.8	1(1.5%)	7(10.8%)	1(1.5%)	47(72.3%)	9(13.8%)
2	The enterprise equipment inventory system is effective and efficient	1.5	0.6	38 (58.5%)	26(40%)	-	1(1.5%)	-
3	The enterprise has monitoring and controlling mechanism to evaluate performance of equipment.	1.7	0.9	31(47.7%)	43(66.1%)	1(1.5%)	8(12.3%)	6(9.2%)
4	The enterprise has effective and efficient monitoring and controlling mechanism to evaluate performance of equipment.	1.4	0.5	41(63.1%)	23(35.4%)	1(1.5%)	-	-

Source: *Own Calculation*

It can also be seen from table 15 above that most (66.1% with mean response 1.7 and SD 0.9) disagreed with existence of monitoring and evaluation to evaluate the performance of equipment. The interview result confirmed as the enterprise did not have integrated monitoring and controlling mechanism to evaluate the performance of equipment. Hence, they suggest the enterprise should establish monitoring and controlling mechanism for equipment evaluation if it is to improve efficient and effective utilization of equipment and thereby achieving its business objective.

4.17. Overall Equipment Management Practice Performance

Respondents were asked to generalize the extent of overall equipment management performance of the enterprise. From table 17 below it can easily be understood that the enterprise overall effectiveness in managing construction equipment from various perspective of equipment management is remains to be poor conditions as majority (67.7%) of the respondents indicated.

Table.17. Overall Equipment Management Practice Performance

	MN	SD	Very poor	Poor	Good	Very good
Overall performance of equipment management practice	2.4	1.0	-	44 (67.7%)	21 (32.3%)	-

Source: *Own Calculation*

Also the survey result confirmed there is the need for interventions to establish effective and efficient equipment management system and thereby improving the competitiveness of the enterprise in the construction business sector where efficient and effective resource utilization is a key success factor for profitability.

4.18. Action to Improve Construction Equipment Management

Respondents were asked to indicate the how good is the extent of actions taken by enterprise to improve construction equipment management. Majority (66.2%) respondents indicated that actions taken by the enterprise to improve the overall equipment management was found to be poor.

Table.16.Level of Action to Improve Construction Equipment Management

	MN	SD	Very poor	Poor	Good	Very good
Level of action to improve construction equipment	2.4	1.0	2(3.1%)	43 (66.2)	12 (18.5%)	8 (12.3%)

Source: *Own Calculation*

According to the interview result, sufficient and quality working tools, well established work shop both at head office and project, qualified and experience operators and drivers,

and computerized equipment management system are of interest areas that need strategic thinking and course of actions so as to improve equipment management in the enterprise

4.19. Maintenance staff efficiency and effectiveness

As indicated in table 18 below, the rate of capacity and effectiveness of maintenance staff the respondents that (50.8%) is poor. But 31(41.7%) of the respondents argue as it is high.

Table.18.Maintenance staff efficiency and effectiveness

	MN	SD	Very poor	Poor	Good	Very good
Maintenance staff efficiency and effectiveness	2.5	0.5	-	33(50.8%)	31(47.7%)	-

Source: *Own Calculation*

The interview survey suggest that lack of spear part is the major factor for construction equipment downtime, in that case the effectiveness of maintenance staff is low on the other hand 31(47.7%) of the respondents responded that the capacity and effectiveness of the enterprise maintenance staff is high. respondents show that with limited resources the respondents indicated that the capacity is high as compared to the amount of equipment the enterprise has.

4.20. Construction Equipment Downtime

Four questions were distributed respondents to examine the extent of factors that account for equipment downtime in the enterprise. It was found (in table 19 below) as lack of spare part availability(63.3% with mean response and SD respondents 0.9)was the major factor contributing for equipment downtime in the enterprise and followed by lack experienced operator and proper management respectively. Improper utilization of equipment by user was identified as least factor contributing for downtime.

Table.19.Factors in Construction Equipment Downtime

	Factors	MN	SD	Very low	Low	High	Very high
1	Lack of experienced operators	3.1	1.0	9 (13.8%)	8(12.3%)	21(32.3%)	27(41.5%)
2	Improper utilization	3.0	1.0	7(10.8%)	3(4.6%)	30(46.2%)	25(38%)
3	Lack of spare parts	3.5	0.9	5(7.7%)	8(12.3%)	11(16.9%)	41(63.3%)
4	Lack of proper management	3.1	1.1	-	5(7.7%)	10(15.4%)	50(76.9%)

Source: *Own Calculation*

The interview result also indicated that lack of spare part availability increase the downtime of equipment. It was also revealed creating strong relationship with key and strategic spare part suppliers, hiring experience operators, continuous capacity development to operators could minimize the risk of equipment downtime.

4.21. Chapter Summary

In this chapter the results of findings has been explained and discussed based on the analysis done on the data collected. The results of the study are discussed by triangulating the different sources results: questionnaire results, interview and document review results. The Data collected using questionnaires were analyzed through descriptive statistics, frequency distribution. The discussion attempted to accomplish the objectives of the study, answer the research questions. The construction equipment management practice and the related challenges, and the factors that could influence construction equipment management practice have been analyzed and presented in the chapter.

Chapter 5

Conclusion and Recommendation

5.1. Introduction

This chapter has two sections. The first section presents the conclusion of the research derived from findings and the second section deals with recommendation that were made on the basis of the findings.

5.2. Conclusion

This study examined the construction equipment management practices and challenges that arise at defense construction enterprise. Three research questions were developed and tested in this study. The first question is to understand the practice of construction equipment management. The second question is to understand the challenges faced by the enterprise in the process of practicing management of construction equipment. The last question is to assess the different factors issues that are related to construction equipment.

The study used document analysis (annual performance reports and other documents), interview with top and middle management members and self-administered questionnaire to top and middle management, project managers' construction equipment administration and maintenance case team leaders of head office and projects, and senior technicians. Questionnaire data were analyzed using descriptive statistics and data from interview and document reviews were interpreted qualitatively.

Equipment management remains a critical competency for the success of construction firms. Even though there are best equipment management methods available theoretically those aids in equipment management process, most equipment managers still use their subjective and potentially inadequate judgments in most of the equipment management decisions.

Generally, as the result obtained from the study and based on its specific objectives the following conclusion are drawn:

- > The current trend of construction equipment management practice in the enterprise is not satisfactory. Unless, it result ineffective management of equipment and will contribute its negative impact to successful accomplishment of the construction projects in DCE on time.
- > The result of the study reveals the existence of construction equipment policy manual at DCE but affirms also that it lacks clarity and simplicity. Moreover, the construction policy manual does not cover various aspects of equipment management.
- > It has been also seen in the study result as DCE prepares short and long range capital budgeting to acquire construction equipment which is primarily made to augment its capacity and competitiveness in the construction sector of the country.
- > Equipment investment proposal is assumed to be initiated from head office and equipment administration and maintenance unit of the enterprise play a vital role in the initiation process. It was also found to be as the enterprise did not adopt quantitative and qualitative method to analyze and select equipment investment proposal alternatives.
- > An internally developed technical and financial criterion is adopted by the enterprise to select construction equipment. Least price, standardization and management decision are the three major criteria used in the equipment selection process.
- > Outright purchase and credit sale were the two main purchase option used by the enterprise to finance construction equipment purchase as they gave advantage of ownership to the equipment and tax benefit to the enterprise
- > It was revealed in the study that DCE did not have well organized and integrated equipment maintenance system. Corrective and unscheduled type of maintenance is mostly practice in the enterprise. As a result of limited practice of corrective type of maintenance in the enterprise, construction projects are not accomplished as per their contractual schedule.

- > Equipment maintenance and repair cost, downtime cost, and obsolescence were the three major factors identified by the survey for equipment replacement decisions of defense construction enterprise. Meanwhile, it was found that the enterprise replaces construction equipment when they are obsolete. Economic analysis is not used to determine replacement time of equipment; only experience and informal analysis is adopted to determine the replacement time of equipment.
- > The survey result asserts that the enterprise holds much old construction equipment that is not functioning economically. Due to the lack of any equipment disposal mechanism in the enterprise, it has not been able to dispose this old construction equipment.
- > Unavailability of spare part is identified in the study as a major challenge to effective equipment management in the enterprise. Lack of equipment standardization practice in the enterprise and unavailability of strong spare part suppliers in the market are two causes for unavailability of spare part. Likewise, lack of computerized management system, unavailability of training and development to employees, lack of experience in construction equipment, and unavailability of skilled and experienced man power are also factors affecting the practice of equipment management in the enterprise.
- > It was revealed in the survey as there were no appropriate ways such as enterprise's own database and formally organized use of other company experience upon which construction equipment rent is determined in the enterprise.
- > Equipment standardization is believed to improve the overall performance of equipment management activity. It plays an important role by increasing the availability of spare part, lowering maintenance cost, improving safety and supplier relationship in the process of equipment maintenance activity.
- > Survey result reveals as construction equipment record keeping is weak in the enterprise. Because of lack of continuous monitoring, controlling and timely action to adjustments by the enterprise, equipment utilization, daily report by operator, timely equipment utilization report, equipment costs and maintenance

data and costs records are not properly undertaken in appropriate manner. Moreover, the existence of manual based method of equipment record keeping makes equipment management activity more difficult.

- > It has been also suggested that the manual based equipment inventory system and the lack of integrated monitoring and evaluation mechanism in the enterprise resulted in inefficient and ineffective performance evaluation of construction equipment.

5.3. Recommendation

Based on the result of the study and conclusion reached together with lesson drawn from literature on experience of other countries to mitigate the major practice of construction equipment management practice and hence achieve sustainable construction equipment management, the following important remarks are recommended.

- > The enterprise needs to strength a CEM policy and develops clear guidelines and procedure on construction equipment management. This should govern the managing practice from selection to final disposal aspects of construction equipment. The policy should give each user of construction equipment a clearly defined right and responsibility in the process.
- > It is necessary for the DCE to establish a system to keep a tracking record for construction equipment data's and costs as well as allowing the staff to acquire necessary knowledge to understand the budget plan and to evaluate it.
- > It is very important to do enterprise wide base line assessment of the existing practice and challenges of construction equipment management as it is a spring board for the following out come in doing so the enterprise should facilitate the financial, personnel and other requirements of the study and successive interventions.
- > The head office and all project members need to focus on creating awareness to all employees throughout the enterprise about construction equipment management and update operating and utilizing of construction equipment.

- > As indicated in the summary and conclusion of the study, the enterprise has poor maintenance practice, to alleviate the poor performance, the construction equipment administration and support process should try to work hard by integrating maintains staff and fulfill all maintenance resources by giving skill development training and updating the current equipment management practice to information technology assisted management practice
- > The enterprise need to facilitate training to all construction equipment support process on economically efficient use of construction equipment in the enterprise and projects.
- > The management should develop institutional construction equipment mechanisms that can enable the enterprise members to make direct participation and provide information to the enterprise in the way that can be easily accessible by concerned body inexpensively. In addition to these it would be more helpful if the construction equipment support process develop construction equipment data base.
- > The enterprise, in consultation with construction equipment support process prepare construction equipment management plan for their construction equipment, which incorporate with the construction enterprise strategic plan.
- > The enterprise should develop a single fixed asset register, using standard classification to describe the construction management and specified details of the equipment, which is linked to the key end user within the enterprise projects and regularly determine the condition of their construction equipment using a standard assessment system.

Finally, in order to achieve the goal and target of defense construction enterprise, the management bodies are expected to perform and assess construction equipment management practice and solve the main challenges that affect the enterprise construction equipment management practice.

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APPENDICES

APPENDICE A: QUESTIONNAIRE

Questionnaires for data collection

Dear respondents

The main purpose of these questionnaires is to seek information regarding the current condition of construction equipment management practices in defense construction enterprise. The information you provide in response to the items in the questionnaire will be used as part of the data needed for the study on ‘an assessment of Construction Equipment Management Practices in Defense Construction Enterprise.’ I am kindly asking you to fill the questionnaire carefully. The quality and quantity of the information you provide determine the ultimate reliability of the research.

I would like to assure you that the information you provide will be accessible only to the academic purpose. Your involvement is regretted as a great input to the quality of the research result. Hence, I believe that you will enlarge your assistance by participation in study.

Kind regards

Bantamlak Abebe

1. Background information about the respondents

a. General Information

b. Please use (V) the relevant box for your response

c. You may choose more than one option when applicable.

Gender: Female Male ☐ ☐ ☐ ☐

2. Educational background

- | | |
|------------------|---|
| 1. MA/Msc | <input type="checkbox"/> |
| 2. BA/Bsc | <input type="checkbox"/> <input type="checkbox"/> |
| 3. Diploma | <input type="checkbox"/> |
| 4. below Diploma | <input type="checkbox"/> |

3. Work experience

- | | |
|----------------------|---|
| 1. Less than 5 years | <input type="checkbox"/> <input type="checkbox"/> |
| 2. 5-10 years | <input type="checkbox"/> <input type="checkbox"/> |
| 3. 10-15 year | <input type="checkbox"/> <input type="checkbox"/> |
| 4. Above 15 year | <input type="checkbox"/> <input type="checkbox"/> |

4. Job title

- | | |
|----------------------|---|
| 1. Top management | <input type="checkbox"/> |
| 2. Middle management | <input type="checkbox"/> |
| 3. Project manager | <input type="checkbox"/> <input type="checkbox"/> |
| 4. Others | <input type="checkbox"/> |

2. General information

The following is five levels Likert Scale format questionnaires

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

Please tick right sign among the alternatives on the space provided

1	Construction equipment policy	Strongly disagree	Disagree	Neutral	Agree	Strong agree
1.1	The enterprise has written standards, guidelines and manuals procedures to manage construction equipment					
1.2	manuals, standards and procedure are clear and easily understandable					
2	Equipment budgeting (planning)					
2.1	The enterprise prepared equipment budgeting every year					
2.2	The enterprise uses standard forms for equipment budgeting request.					
3	Construction Equipment Investment					
3.1	Construction equipment investment proposal is initiated at head office by core processes					
3.2	Construction equipment administration and maintenance support process initiate investment proposal					
3.3	Project managers initiate equipment investment proposal					
3.4	Both qualitative and quantitative evaluation is adopted to analyze investment proposal.					
3.5	Both qualitative and quantitative method of evaluation is adopted to analyze investment proposal					
3.6	There is qualitative and quantitative methods of determination to select equipment investment proposal					

4	Construction equipment selection determination					
4.1	Enterprise uses internally developed technical and financial criteria					
4.2	Least price criteria					
4.3	Determined by management					
4.4	Standardization of construction equipment					
4.5	Past experience and information from other user					
5.	Methods that taken in to account in construction equipment purchase decision					
5.1	Hire purchase is adopted in the enterprise					
5.2	Outright purchase is common in the enterprise					
5.3	Leasing using a finance lease					
5.4	Credit sale					
5.5	Others methods					
6	Equipment rental determination					
6.1	Enterprise's own database					
6.2	Governmental rate					
6.3	From standard publication					
6.4	The enterprise doesn't use clear and standard criteria					
6.5	Other similar construction company experience					
7	Maintenance of construction equipment					
7.1	The enterprise has well organized and integrated maintenance system					
7.2	Corrective type of maintenance is undertaken in the enterprise					
7.3	Unscheduled type of maintenance is undertaken in the enterprise					
7.4	Preventive type of maintenance is undertaken in the enterprise					
8	Construction equipment replacement time					

8.1	The enterprise makes economic analysis to replace equipment					
8.2	The enterprise replaces equipment when they are inefficient					
8.3	The enterprise replaces old equipment before new project is hand over					
8.4	The enterprise replaces equipment before major overhaul					
8.5	The enterprise replaces equipment when it is obsolete					
8.6	The enterprise uses formal economic analysis for construction replacement decision					
8.7	The enterprise uses experience and formal analysis for construction equipment replacement decision.					
8.8	The enterprise uses experience and informal analysis for replacement decision					
9	Major factors in equipment replacement factors					
9.1	Maintenance and repair cost					
9.2	Down time					
9.3	Depreciation					
9.4	Inflation					
9.5	Obtainable resale value					
9.6	Obsolesce					
9.7	High cost of investment					
10	Disposal					
10.1	DCE trades construction equipment to dealers					
10.2	The enterprise disposes construction equipment through auction sale					
10.3	The enterprise disposes construction through third party					
10.4	The enterprise doesn't has Disposal mechanism of construction equipment					
11	Benefit of equipment Standardization					

11.1	Standardizations can save spare part availability for the					
11.2	Standardizations can lower maintenance costs					
11.3	Standardizations can bring better performance of the enterprise					
11.4	Standardizations can make ease for construction equipment management issues					
12	Construction equipment record keeping					
12.1	Equipment utilization record is properly maintained both at head office and projects					
12.2	Operator record daily report					
12.3	equipment utilization report is filled timely					
12.4	There is an appropriate method of data recording					
12.5	Construction equipment costs are recorded properly					
12.6	Maintenance data and costs are recorded properly					
13	Equipment monitoring and controlling					
13.1	The enterprise has construction equipment inventory system.					
13.2	The enterprise equipment inventory system is effective and efficient					
13.3	The enterprise has monitoring and controlling mechanism to evaluate performance of equipment.					
13.4	The enterprise has effective and efficient monitoring and controlling mechanism to evaluate performance of equipment.					
14	Challenges in practicing construction equipment management in defense construction enterprise					
14.1	The high cost of construction equipment management system					
14.2	Lack of experience in managing construction equipment					
14.3	It is complex task					

14.4	Lack of skilled manpower in the construction equipment management system					
14.5	lack of construction equipment implementation guideline and procedure					
14.6	Lack of well-established IT system to manage equipment					
14.7	Unavailability Training and development for construction equipment support process members					
14.8	Location of projects and unfavorable weather condition					
14.9	Unavailability of spare parts					

3. Self-administered close ended questionnaires

- Do you think that the enterprise has construction equipment management principles and guidelines?

A. Yes ☐ B. No ☐

- How do you see the action taken by Defense Construction Enterprise to better organize the construction equipment administration and maintenance support process?

A) Very good ☐ B) Good ☐ C) Poor ☐ D) Very poor ☐

E) I can't comment ☐

- How do you rate the maintenance staff capacity and their effectiveness on the construction equipment?

A) Very good ☐ B) Good ☐ C) Poor ☐ D) Very poor ☐

E) I can't comment ☐

- What are major factors which have significant impact in construction equipment down time? A. Lack of experienced operator ☐ B. Improper utilization ☐

C. Lack of spare part ☐ D. Lack of proper management ☐ E. Lack of experienced operator ☐

- How are the drivers And Operators Capacity and their impact on construction

Equipment?

A. Very Good

B. Good

C. PO

D. very p

6. How do you see the overhaul Performance of construction_____ [hpment management practice in DCE?

A. Very Good

B. Good

C. Poor

D. Very Poor

APPENDICE (B): INTERVIEW

Interview question for top and middle management members and project managers

Dear respondents, this interview are conducted for an academic purposed of the fulfillment of master degree in MBA. Specifically the objective of the Study is to assess the current practice of construction equipment management practice in DCE. There for, your response is very important for the success of the research study. Hence, you are kindly request to give your response please be informed that your response kept in confidential. I would like to thank you for your cooperation.

1. Does your construction equipment needs determined in a consistent manner based on established construction equipment management policy?
2. Does the enterprise use process for identifying the most cost effective means of the construction equipment (E.g. Own Versus rent) Are there any construction equipments manual that haves guide how construction equipment should be controlled In DCE?
3. Do you think employees of Defense Construction Enterprise have clear awareness of the contents of the construction equipment manual?
4. According to your personal evaluation, to what extent is the success of the construction equipment maintenance of the enterprise?
5. Do you feel your equipment support process has adequate capacity to handle CEM

Responsibilities?

6. What do you think should be done to improve the situation CEM of the enterprise in general?

APPENDICE (C): SPSS output

Sex

	Frequency	Percent	Valid percent	Cumulative percent
Male	53	81.5	81.5	81.5
Valid Female	12	18.5	18.5	100.0
Total	65	100.0	100.0	

Education

	Frequency	Percent	Valid percent	Cumulative percent
Ma/msc	5	7.7	7.7	7.7
Ba/bsc	42	64.6	64.6	72.3
Valid Diploma	16	24.6	24.6	96.9
Below diploma	2	3.1	3.1	100.0
Total	65	100.0	100.0	

Work experience

	Frequency	Percent	Valid percent	Cumulative percent
< five year	7	10.8	10.8	10.8
5 -10 year	13	20.0	20.0	30.8
Valid 11- 15 year	32	49.2	49.2	80.0
Above 15 year	13	20.0	20.0	100.0
Total	65	100.0	100.0	

Job position				
	Frequency	Percent	Valid percent	Cumulative percent
Top management	5	7.7	7.7	7.7
Middle management	15	23.1	23.1	30.8
Project manager	11	16.9	16.9	47.7
Equipment	14	21.5	21.5	69.2
Valid administration and maintenance team leader				
Senior technician	20	30.8	30.8	100.0
Total	65	100.0	100.0	

The enterprise prepared equipment budgeting every year				
	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	2	6.5	6.5	6.5
Neutral	1	3.2	3.2	9.7
Valid Agree	20	64.5	64.5	74.2
Strongly agree	8	25.8	25.8	100.0
Total	31	100.0	100.0	

The enterprise uses standard forms for equipment budgeting request				
	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly disagree	1	3.2	3.2	3.2
Disagree	5	16.1	16.1	19.4
Valid Neutral	12	38.7	38.7	58.1
Agree	12	38.7	38.7	96.8
Strongly agree	1	3.2	3.2	100.0
Total	31	100.0	100.0	

Construction equipment investment proposal is initiated at head office				
	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	2	6.5	6.5	6.5
Valid Agree	13	41.9	41.9	48.4
Strongly agree	16	51.6	51.6	100.0
Total	31	100.0	100.0	

Construction equipment investment proposal is initiated by equipment and maintenance support process

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	6.5	6.5
	Disagree	15	48.4	54.8
	Neutral	1	3.2	58.1
	Agree	2	6.5	64.5
	Strongly agree	11	35.5	100.0
	Total	31	100.0	

Project managers initiate equipment investment

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	2	6.5	6.5
	Disagree	28	90.3	96.8
	Neutral	1	3.2	100.0
	Total	31	100.0	

Qualitative and quantitative method of evaluation is adopted to analyze investment proposal

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	11	35.5	35.5
	Disagree	17	54.8	90.3
	Neutral	1	3.2	93.5
	Agree	2	6.5	100.0
	Total	31	100.0	

Qualitative and quantitative method of evaluation is adopted to determine the selection of investment proposal

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	12	38.7	38.7
	Disagree	16	51.6	90.3
	Neutral	1	3.2	93.5
	Agree	2	6.5	100.0
	Total	31	100.0	

The enterprise uses internally developed technical and financial criteria

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	3	9.7	9.7
	Disagree	4	12.9	22.6
	Neutral	1	3.2	25.8
	Agree	14	45.2	71.0
	Strongly agree	9	29.0	100.0
	Total	31	100.0	

Least price criteria

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	1	3.2	3.2
	Disagree	7	22.6	25.8
	Neutral	5	16.1	41.9
	Agree	17	54.8	96.8
	Strongly agree	1	3.2	100.0
	Total	31	100.0	

Equipment selection is determined by management

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	6	19.4	19.4
	Neutral	5	16.1	35.5
	Agree	13	41.9	77.4
	Strongly agree	7	22.6	100.0
	Total	31	100.0	

Equipment selection is determined based on equipment standardization

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly disagree	1	3.2	3.2	3.2
Disagree	10	32.3	32.3	35.5
Neutral	5	16.1	16.1	51.6
Agree	15	48.4	48.4	100.0
Total	31	100.0	100.0	

The enterprise makes equipment selection based on the past experience and information of other users

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly disagree	7	22.6	22.6	22.6
Disagree	7	22.6	22.6	45.2
Neutral	6	19.4	19.4	64.5
Agree	11	35.5	35.5	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made based on full economic utilization of equipment

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly disagree	9	29.0	29.0	29.0
Disagree	7	22.6	22.6	51.6
Neutral	2	6.5	6.5	58.1
Agree	13	41.9	41.9	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made based on less cost of using equipment

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly disagree	4	12.9	12.9	12.9
Disagree	15	48.4	48.4	61.3
Neutral	3	9.7	9.7	71.0
Agree	9	29.0	29.0	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made to increase in enterprise asset

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Strongly disagree	11	35.5	35.5	35.5
Disagree	11	35.5	35.5	71.0
Neutral	2	6.5	6.5	77.4
Agree	7	22.6	22.6	100.0

Total 31 100.0 100.0

Equipment purchase decision is made based on the price of equipment

	Frequency	Percent	Valid Percent	Cumulative Percent
Missing value	1	3.2	3.2	3.2
Disagree	1	3.2	3.2	6.5
Neutral	1	3.2	3.2	9.7
Agree	20	64.5	64.5	74.2
Strongly agree	8	25.8	25.8	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made based on performance and mentality

	Frequency	Percent	Valid Percent	Cumulative Percent
Neutral	5	16.1	16.1	16.1
Agree	20	64.5	64.5	80.6
Strongly agree	6	19.4	19.4	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made based on fuel consumption

	Frequency	Percent	Valid Percent	Cumulative Percent
Neutral	5	16.1	16.1	16.1
Agree	23	74.2	74.2	90.3
Strongly agree	3	9.7	9.7	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made based standardization of equipment

	Frequency	Percent	Valid Percent	Cumulative Percent
Missing value	2	6.5	6.5	6.5
Strongly disagree	4	12.9	12.9	19.4
Disagree	18	58.1	58.1	77.4
Neutral	3	9.7	9.7	87.1
Agree	4	12.9	12.9	100.0
Total	31	100.0	100.0	

Equipment purchase decision is made based on past experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	8	25.8	25.8	25.8
	Agree	16	51.6	51.6	77.4
	Strongly agree	7	22.6	22.6	100.0
	Total	31	100.0	100.0	

Equipment purchase decision is made based on after sales service

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	7	22.6	22.6	22.6
	Disagree	8	25.8	25.8	48.4
	Agree	16	51.6	51.6	100.0
	Total	31	100.0	100.0	

Equipment rent is determined based on enterprises own data base

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	8	25.8	25.8	25.8
	Disagree	11	35.5	35.5	61.3
	Agree	12	38.7	38.7	100.0
	Total	31	100.0	100.0	

Equipment rent is determined based on government rate

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	10	32.3	32.3	32.3
	Disagree	12	38.7	38.7	71.0
	Neutral	3	9.7	9.7	80.6
	Agree	6	19.4	19.4	100.0
	Total	31	100.0	100.0	

Equipment rent is determined based on standard publication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid ⁵	Missing value	1	3.2	3.2	3.2
	Strongly disagree	14	45.2	45.2	48.4
	Disagree	3	9.7	9.7	58.1
	Neutral	12	38.7	38.7	96.8
	Agree	1	3.2	3.2	100.0
	Total	31	100.0	100.0	

Equipment rent is determined based on other similar construction company experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	12	38.7	38.7	38.7
	Neutral	8	25.8	25.8	64.5
	Agree	11	35.5	35.5	100.0
	Total	31	100.0	100.0	

DCE trades construction equipment to dealers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Missing value	5	16.1	16.1	16.1
	Strongly disagree	3	9.7	9.7	25.8
	Disagree	17	54.8	54.8	80.6
	Neutral	6	19.4	19.4	100.0
	Total	31	100.0	100.0	

The enterprise disposes construction equipment through auction sale

	Frequency	Percent	Valid Percent	Cumulative Percent
Missing value	5	16.1	16.1	16.1
Strongly disagree	10	32.3	32.3	48.4
Valid Disagree	15	48.4	48.4	96.8
Neutral	1	3.2	3.2	100.0
Total	31	100.0	100.0	

The enterprise disposes construction through third party

	Frequency	Percent	Valid Percent	Cumulative Percent
Missing value	5	16.1	16.1	16.1
Strongly disagree	3	9.7	9.7	25.8
Valid Disagree	13	41.9	41.9	67.7
Neutral	8	25.8	25.8	93.5
Agree	2	6.5	6.5	100.0
Total	31	100.0	100.0	

There is disposal mechanism of construction equipment

	Frequency	Percent	Valid Percent	Cumulative Percent
Missing value	2	6.5	6.5	6.5
Strongly disagree	21	67.7	67.7	74.2
Valid Disagree	8	25.8	25.8	100.0
Total	31	100.0	100.0	

The enterprise has written policy, standard, guideline and procedure to manage construction equipment

	Frequency	Percent	Valid percent	Cumulative percent
Valid ⁵ Neutral	2	3.1	3.1	3.1
Agree	50	76.9	76.9	80.0
Strongly agree	13	20.0	20.0	100.0
Total	65	100.0	100.0	

The enterprise has written policy, standard, guideline and procedure are clear and easily understandable

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	19	29.2	29.2	29.2
Disagree	37	56.9	56.9	86.2
Valid Neutral	8	12.3	12.3	98.5
Agree	1	1.5	1.5	100.0
Total	65	100.0	100.0	

The enterprise has well organized and integrated maintenance system

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	16	24.6	24.6	24.6
Disagree	31	47.7	47.7	72.3
Valid Agree	14	21.5	21.5	93.8
Strongly agree	4	6.2	6.2	100.0
Total	65	100.0	100.0	

Unscheduled type of maintenance is practiced in the enterprise

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	14	21.5	21.5	21.5
	Disagree	3	4.6	4.6	26.2
	Neutral	1	1.5	1.5	27.7
	Agree	44	67.7	67.7	95.4
	Strongly agree	3	4.6	4.6	100.0
	Total	65	100.0	100.0	

Preventive type of maintenance is practiced in the enterprise

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	23	35.3	35.3	35.4
	Disagree	24	36.9	36.9	72.2
	Neutral	1	1.5	1.5	73.7
	Agree	10	15.3	15.3	88.3
	Strongly agree	7	10.7	10.7	100.0
	Total	65	100.0	100.0	

The enterprise makes economic analysis to replace equipment

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	19	29.2	29.2	29.2
	Disagree	36	55.4	55.4	84.6
	Neutral	7	10.8	10.8	95.4
	Agree	3	4.6	4.6	100.0
	Total	65	100.0	100.0	

The enterprise replaces equipment when they are inefficient

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	13	20.0	20.0	20.0

Disagree	30	46.2	46.2	66.2
Neutral	7	10.8	10.8	76.9
Agree	11	16.9	16.9	93.8
Strongly agree	4	6.2	6.2	100.0
Total	65	100.0	100.0	

The enterprise replaces old equipment before new project is hand over

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	13	20.0	20.0	20.0
Disagree	32	49.2	49.2	69.2
Neutral	7	10.8	10.8	80.0
Agree	13	20.0	20.0	100.0
Total	65	100.0	100.0	

The enterprise replaces equipment before major overhaul

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	18	27.7	27.7	27.7
Disagree	36	55.4	55.4	83.1
Neutral	8	12.3	12.3	95.4
Agree	3	4.6	4.6	100.0
Total	65	100.0	100.0	

The enterprise replaces equipment when it is obsolete

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	1	1.5	1.5	1.5
Disagree	22	33.8	33.8	35.4
Neutral	2	3.1	3.1	38.5
Agree	26	40.0	40.0	78.5
Strongly agree	14	21.5	21.5	100.0
Total	65	100.0	100.0	

The enterprise uses formal economic analysis for construction replacement decision

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	18	27.7	27.7	27.7
Disagree	45	69.2	69.2	96.9

Agree	1 ²	3.1	3.1	100.0
Total	65	100.0	100.0	

The enterprise uses experience and formal analysis for construction equipment replacement decision.

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	24	36.9	36.9	36.9
Disagree	39	60.0	60.0	96.9
Agree	2	3.1	3.1	100.0
Total	65	100.0	100.0	

The enterprise uses experience and informal analysis for replacement decision

	Frequency	Percent	Valid percent	Cumulative percent
Valid ⁵ Disagree	29	44.6	44.6	44.6
Agree	16	24.6	24.6	69.2
Strongly agree	20	30.8	30.8	100.0
Total	65	100.0	100.0	

Maintenance and repair cost

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	7	10.8	10.8	10.8
Disagree	4	6.2	6.2	16.9
Neutral	1	1.5	1.5	18.5
Agree	38	58.5	58.5	76.9
Strongly agree	15	23.1	23.1	100.0
Total	65	100.0	100.0	

Down time

	Frequency	Percent	Valid percent	Cumulative percent
Valid Disagree	1	1.5	1.5	1.5
Agree	51	78.5	78.5	80.0
Strongly agree	13	20.0	20.0	100.0
Total	65	100.0	100.0	

Depreciation

Frequency	Percent	Valid percent	Cumulative percent
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Valid	Strongly disagree	10	15.4	15.4	15.4
	Disagree	17	26.2	26.2	41.5
	Neutral	11	16.9	16.9	58.5
	Agree	27	41.5	41.5	100.0
	Total	65	100.0	100.0	

Inflation

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	9	13.8	13.8	13.8
	Disagree	27	41.5	41.5	55.4
	Neutral	19	29.2	29.2	84.6
	Agree	10	15.4	15.4	100.0
	Total	65	100.0	100.0	

Obtainable resale value

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	14	21.5	21.5	21.5
	Disagree	35	53.8	53.8	75.4
	Neutral	2	3.1	3.1	78.5
	Agree	14	21.5	21.5	100.0
	Total	65	100.0	100.0	

Obsolesce

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Disagree	2	3.1	3.1	3.1
	Neutral	10	15.4	15.4	18.5
	Agree	28	43.1	43.1	61.5
	Strongly agree	25	38.5	38.5	100.0
	Total	65	100.0	100.0	

High cost of investment

		Frequency	Percent	Valid percent	Cumulative percent
Valid ⁵	Disagree	30	46.2	46.2	46.2
	Agree	28	43.1	43.1	89.2
	Strongly agree	7	10.8	10.8	100.0
	Total	65	100.0	100.0	

Standardizations can save spear part availability for the

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	1	1.5	1.5	1.5
Neutral	1	1.5	1.5	3.1
Valid Agree	46	70.8	70.8	73.8
Strongly agree	17	26.2	26.2	100.0
Total	65	100.0	100.0	

Standardizations can lower maintenance costs

	Frequency	Percent	Valid percent	Cumulative percent
Neutral	7	10.8	10.8	10.8
Valid Agree	49	75.4	75.4	86.2
Strongly agree	9	13.8	13.8	100.0
Total	65	100.0	100.0	

Standardizations can bring better performance of the enterprise

	Frequency	Percent	Valid percent	Cumulative percent
Disagree	1	1.5	1.5	1.5
Neutral	10	15.4	15.4	16.9
Valid Agree	41	63.1	63.1	80.0
Strongly agree	13	20.0	20.0	100.0
Total	65	100.0	100.0	

Standardizations can make ease for ce management issues

	Frequency	Percent	Valid percent	Cumulative percent
Neutral	8	12.3	12.3	12.3
Valid Agree	40	61.5	61.5	73.8
Strongly agree	17	26.2	26.2	100.0
Total	65	100.0	100.0	

Equipment utilization record is properly maintained both at head office and projects

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	6	9.2	9.2	9.2
Disagree	29	44.6	44.6	53.8
Valid Neutral	6	9.2	9.2	63.1
Agree	18	27.7	27.7	90.8
Strongly agree	6	9.2	9.2	100.0
Total	65	100.0	100.0	

Operator record daily report

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	4	6.2	6.2	6.2
Disagree	32	49.2	49.2	55.4
Valid Neutral	12	18.5	18.5	73.8
Agree	17	26.2	26.2	100.0
Total	65	100.0	100.0	

Equipment utilization report is filled timely

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	12	18.5	18.5	18.5
Disagree	38	58.5	58.5	76.9
Valid Neutral	6	9.2	9.2	86.2
Agree	9	13.8	13.8	100.0
Total	65	100.0	100.0	

There is an appropriate method of data recording

	Frequency	Percent	Valid percent	Cumulative percent
Strongly disagree	12	18.5	18.5	18.5
Disagree	35	53.8	53.8	72.3
Valid Neutral	5	7.7	7.7	80.0
Agree	13	20.0	20.0	100.0
Total	65	100.0	100.0	

Construction equipment costs are recorded properly

	Frequency	Percent	Valid percent	Cumulative percent
Missing value	2	3.1	3.1	3.1
Strongly disagree	5	7.7	7.7	10.8
Valid Disagree	39	60.0	60.0	70.8
Neutral	5	7.7	7.7	78.5
Agree	14	21.5	21.5	100.0
Total	65	100.0	100.0	

Maintenance data and costs are recorded properly

	Frequency	Percent	Valid percent	Cumulative percent
Missing value	1	1.5	1.5	1.5
Valid Strongly disagree	4	6.2	6.2	7.7
Disagree	39	60.0	60.0	67.7

Neutral	6	9.2	9.2	76.9
Agree	15	23.1	23.1	100.0
Total	65	100.0	100.0	

The enterprise has construction equipment inventory system

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	1	1.5	1.5	1.5
Disagree	7	10.8	10.8	12.3
Neutral	1	1.5	1.5	13.8
Agree	47	72.3	72.3	86.2
Strongly agree	9	13.8	13.8	100.0
Total	65	100.0	100.0	

The enterprise equipment inventory system is effective and efficient t

	Frequency	Percent	Valid percent	Cumulative percent
Valid ⁵ Strongly disagree	38	58.5	58.5	58.5
Disagree	26	40.0	40.0	98.5
Agree	1	1.5	1.5	100.0
Total	65	100.0	100.0	

The enterprise has monitoring and controlling mechanism to evaluate performance of equipment.

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	31	47.7	47.7	47.7
Disagree	27	41.5	41.5	89.2
Neutral	1	1.5	1.5	90.8
Agree	6	9.2	9.2	100.0
Total	65	100.0	100.0	

The enterprise has effective and efficient monitoring and controlling mechanism to evaluate performance of equipment.

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	41	63.1	63.1	63.1
Disagree	23	35.4	35.4	98.5
Neutral	1	1.5	1.5	100.0
Total	65	100.0	100.0	

The high cost of construction equipment management system

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	1	1.5	1.5	1.5
Disagree	34	52.3	52.3	53.8
Neutral	8	12.3	12.3	66.2
Agree	21	32.3	32.3	98.5
Strongly agree	1	1.5	1.5	100.0
Total	65	100.0	100.0	

Lack of experience in managing construction equipment

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	1	1.5	1.5	1.5
Disagree	13	20.0	20.0	21.5
Neutral	10	15.4	15.4	36.9
Agree	33	50.8	50.8	87.7
Strongly agree	8	12.3	12.3	100.0
Total	65	100.0	100.0	

It is complex task

	Frequency	Percent	Valid percent	Cumulative percent
Valid Missing value	1	1.5	1.5	1.5
Strongly disagree	16	24.6	24.6	26.2
Disagree	20	30.8	30.8	56.9
Neutral	2	3.1	3.1	60.0
Agree	19	29.2	29.2	89.2
Strongly agree	7	10.8	10.8	100.0
Total	65	100.0	100.0	

Lack of skilled manpower in the filed

	Frequency	Percent	Valid percent	Cumulative percent
Valid Strongly disagree	7	10.8	10.8	10.8
Disagree	14	21.5	21.5	32.3
Neutral	1	1.5	1.5	33.8
Agree	41	63.1	63.1	96.9
Strongly agree	2	3.1	3.1	100.0
Total	65	100.0	100.0	

Lack of construction equipment implementation guideline and procedure

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Disagree	36	55.4	55.4	55.4
	Neutral	14	21.5	21.5	76.9
	Agree	14	21.5	21.5	98.5
	Strongly agree	1	1.5	1.5	100.0
	Total	65	100.0	100.0	

Lack of well-established it system to manage equipment

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Disagree	4	6.2	6.2	6.2
	Neutral	1	1.5	1.5	7.7
	Agree	40	61.5	61.5	69.2
	Strongly agree	20	30.8	30.8	100.0
	Total	65	100.0	100.0	

Unavailability training development

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Disagree	4	6.2	6.2	6.2
	Neutral	14	21.5	21.5	27.7
	Agree	32	49.2	49.2	76.9
	Strongly agree	15	23.1	23.1	100.0
	Total	65	100.0	100.0	

Location of projects and unfavorable weather condition

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Strongly disagree	16	24.6	24.6	24.6
	Disagree	15	23.1	23.1	47.7
	Neutral	1	1.5	1.5	49.2
	Agree	33	50.8	50.8	100.0
	Total	65	100.0	100.0	

Unavailability of spare parts

	Frequency	Percent	Valid percent	Cumulative percent
Disagree	3	4.6	4.6	4.6
Neutral	1	1.5	1.5	6.2
Agree	21	32.3	32.3	38.5
Strongly agree	40	61.5	61.5	100.0
Total	65	100.0	100.0	

Action taken to improve construction equipment by enterprise

	Frequency	Percent	Valid percent	Cumulative percent
Very good	2	3.1	3.1	3.1
Good	43	66.2	66.2	69.2
Poor	12	18.5	18.5	87.7
Very poor	8	12.3	12.3	100.0
Total	65	100.0	100.0	

Overall performance of equipment management practice

	Frequency	Percent	Valid percent	Cumulative percent
Good	44	67.7	67.7	67.7
Poor	21	32.3	32.3	100.0
Total	65	100.0	100.0	

Awareness given to employees about handling and utilizing equipment's

	Frequency	Percent	Valid percent	Cumulative percent
Very good	1	1.5	1.5	1.5
Good	54	83.1	83.1	84.6
Poor	10	15.4	15.4	100.0
Total	65	100.0	100.0	

Driver and operators efficiency and effectiveness

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Very high	1	1.5	1.5	1.5
	High	31	47.7	47.7	49.2
	Low	33	50.8	50.8	100.0
	Total	65	100.0	100.0	

Lack of experienced operators

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Very high	8	12.3	13.8	13.8
	High	9	13.8	3.4	17.2
	Low	27	41.5	46.6	63.8
	Very low	21	32.3	36.2	100.0
	Total	58	89.2	100.0	
	Total	65	100.0		

Improper utilization

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Very high	25	38.4	13.8	13.8
	High	30	46.1	5.2	19.0
	Low	3	4.6	51.7	70.7
	Very low	7	10.8	29.3	100.0
	Total	65	100.0		

Lack of spare parts

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Very high	41	63.3	8.6	8.6
	High	11	16.9	1.7	10.3
	Low	8	12.3	19.0	29.3
	Very low	5	7.7	70.7	100.0
	Total	65	100.0		

Lack of proper management

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Very high	50	76.9	19.0	19.0
	Low	10	15.4	32.8	51.7
	Very low	5	7.7	48.3	100.0
	Total	65	100.0	100.0	
Total		65	100.0		

The impact of operators and drivers capacity on equipment's

		Frequency	Percent	Valid percent	Cumulative percent
Valid	High	37	56.9	56.9	56.9
	Low	26	40.0	40.0	96.9
	Very low	2	3.1	3.1	100.0
	Total	65	100.0	100.0	

DECLARATION

I, the undersigned, declare that the research study entitled” an assessment of construction equipment management practice in defense construction enterprise ” my own work. I have undertaken the research work independently with the guidance and support of the research advisor. This study has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Declared by: BANTAMLAK ABEBE

Signature: _____

St.Mary’s University College, Addis Ababa

August, 2013

ENDORSEMENT

This research has been submitted to St.Mary University College, School of Graduate Studies for examination with my approval as a University advisor.

Advisor: Abebe Yitayew (Ass.Pro)

Signature: _____

St.Mary's University College, Addis Ababa October, 2013



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